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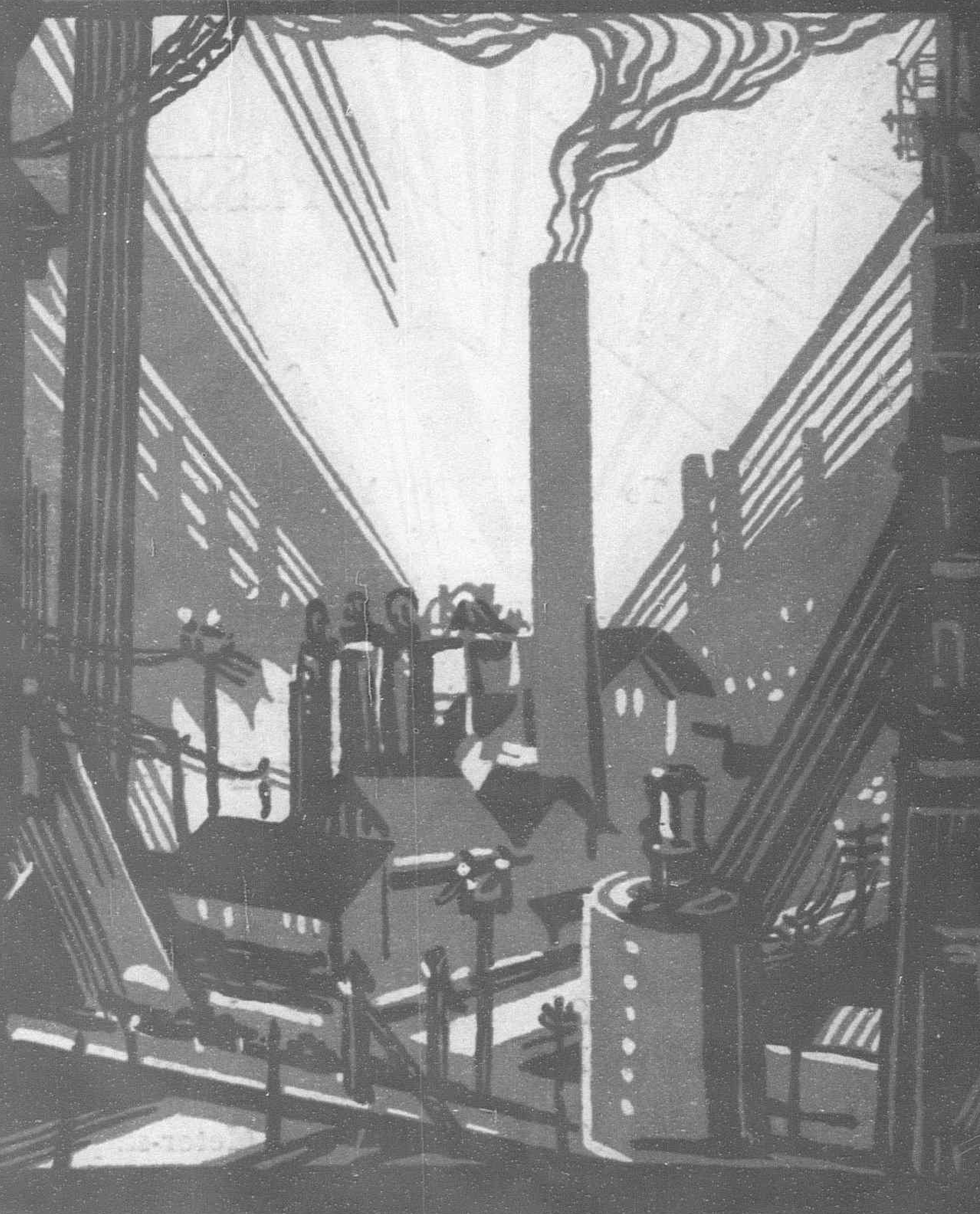

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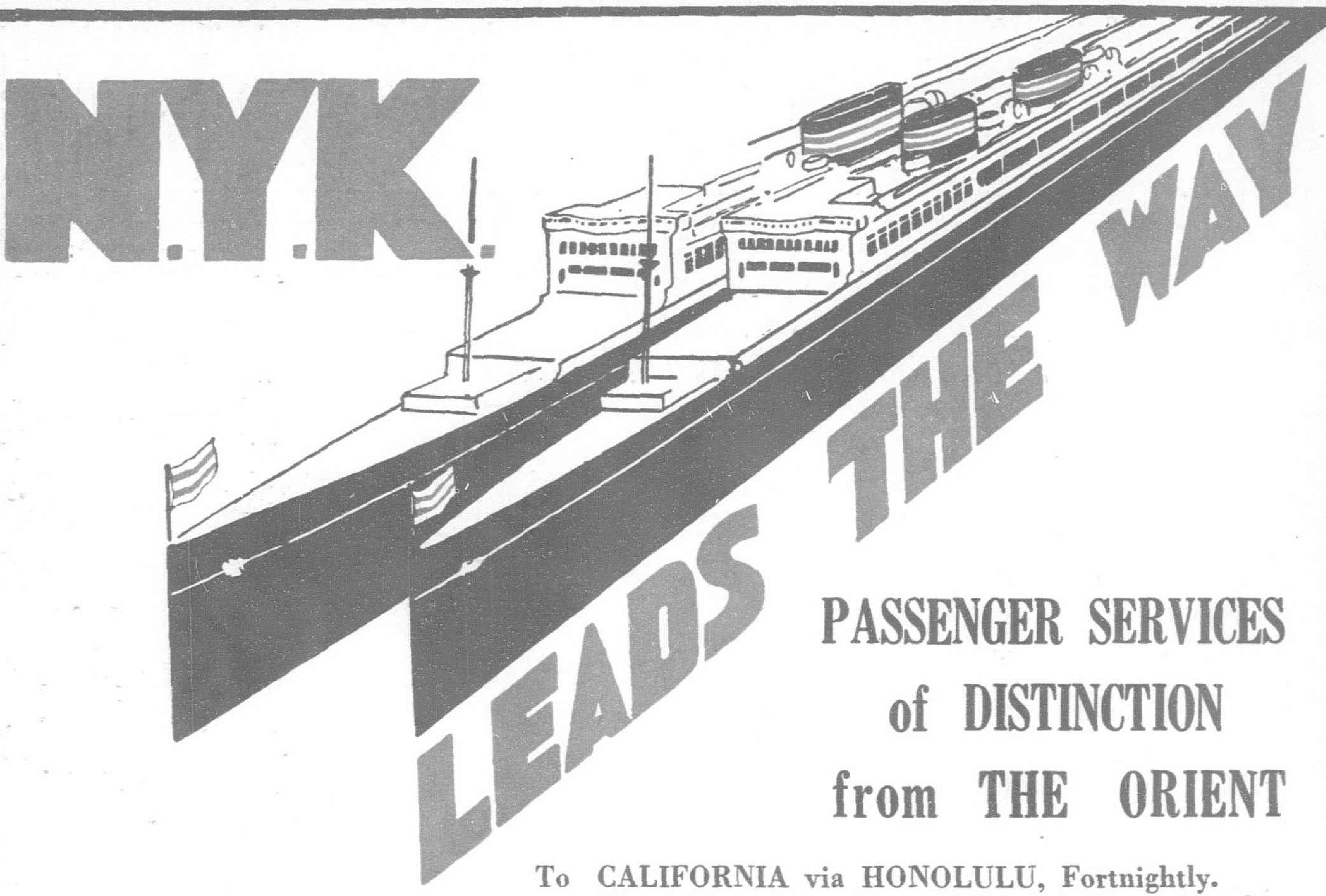

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The Far Eastern Review

ENGINEERING FINANCE COMMERCE

VOL. XXVI SHANGHAI, MAY, 1930 No. 5

The China Policy of Baron Shidehara

By *GEORGE E. SOKOLSKY*

THE signing of the new Sino-Japanese Tariff Treaty marks the first stage of the fruition of the new China policy of the Japanese Government. Conceived at the time of the Washington Conference, this policy has slowly been making itself recognized in Japan, where it met with no fewer misgivings than in China. The policy involves a complete negation of any schemes which may have been developed in Japan previous to the Washington Conference for territorial conquest on the mainland of Asia; it concerns the establishment of the closest ties of friendship and co-operation between China and Japan; it re-orientates Japanese diplomacy from a political to an economic basis in China; it replaces antagonizing incidents with open helpfulness in the re-establishment of China as a powerful Asiatic state. In short, this policy seeks to find a formula for a partnership between China and Japan in the economic development of Asia and if that partnership requires sacrifices on the part of Japan, while China is readjusting to a changing domestic political situation, Japan is prepared to make those sacrifices.

Mr. K. Debuchi, the Japanese Ambassador to the United States in addresses delivered in that country in explanation of Japan's policy in China, emphasized constantly the economic significance to Japan of China's commercial expansion. He has even gone so far as to suggest that in the growth of American trade in China, Japan could rejoice as she to likely to benefit from any economic developments in China. This is a self-evident truth, for from the invisible profits alone, such as shipping, insurance, handling charges, etc. Japan's share in the American trade with China is likely to be enormous, while actually a very large part of American merchandize sold in China is being handled there by Japanese firms, while numerous American manufacturers are opening and have opened factories in Japan for the manufacture of American commodities to be sold on the Chinese as well as the Japanese market. In a word, Japan benefits in every possible direction from the expansion of China's trade, but there can be no trade expansion unless there is peace in China and unless whatever Government there may be has authority in the zones of territory which it governs.

Incident after incident arose in China to mar Sino-Japanese relations and to impede the full development of the new policy. The Tsinan incident, in particular, proved a set-back from which recovery was exceedingly difficult. It was only by the assertion of the will to be friends that ultimately the two nations found a basis for agreement and for mutual assistance and co-operation. Baron Shidehara, in particular, has permitted no untoward incident, no boggling of relations in Nanking, no silly obstacles raised by idealogues to prevent the consummation of a policy upon which is to be based the relations between China and Japan, not only immediately, but for years and even decades to come. In planning for a long future, it is not difficult to overlook the misfortunates of the moment, to disregard the pin-pricks which politicians emphasize but which statesmen can afford to ignore. Thus when the National Government wounded the pride of a deeply sincere friend of China, Mr. Obata, the Japanese Government did not permit such an incident to wipe out the statesmanly insistence upon peace and friendship between the two countries. Mr. Shigemitsu, the Consul-General in Shanghai, was appointed Chargé d'Affaires and was instructed to continue the treaty negotiations. It can be no secret that it was largely due to the warm personal friendships between the Chinese and the Japanese negotiators that the treaty was finally signed, for neither China nor Japan has won a diplomatic victory in the new treaty. Neither China nor Japan will be fully satisfied. Ratification of the treaty was delayed in the Privy Council because of numerous objections in Japan; it was delayed in the Legislative Yuan because of numerous objections in China. Nevertheless, the Treaty is now signed and ratified. China and Japan are again in Treaty Relationship. The next stage is the negotiation of a new Commercial Treaty, which will be an even more difficult task but not an insurmountable one. For the will to friendship between China and Japan exists and that will find a formula for improved treaty relationships.

It is this relationship of friendship that Baron Shidehara stresses so often in his address before the Diet on April 23, when, referring to Japan's diplomatic relations wilth China, he said:

> On January 21 last, I had the honor to address this House, and to define the general lines of policy which the Government proposed to follow on various diplomatic problems confronting this country. Nothing has happened since calling for any alteration of these policies. I shall, therefore, avoid repetition and confine myself on this occasion to stating the outline of a few of the latest developments in our international relations.
>
> Between Japan and China, an agreement relating to customs duties is now ready for signature. Its main features are a recognition by Japan of China's Tariff autonomy and reciprocal undertakings on tariff for a number of commodities.
>
> Concerning the customs autonomy of China, a resolution for its recognition in principle was adopted by a special committee at the Peking Tariff Conference of 1925. It is a matter of common knowledge that the Japanese representatives at the Conference played a rôle of signal importance in securing the passage of that resolution. Owing to the threatening development of domestic warfare in China, the Peking Conference was brought to a close without any definite result being attained. Subsequently, however, customs agreements have been concluded in succession by various Powers with China. With the conclusion of the similar agreement between Japan and China now awaiting signature, the formal recognition of China's customs autonomy by all the nations concerned will have become complete. Nothing is more gratifying to us than to witness such a notable achievement on the part of that neighboring nation. At the same time, a measure of responsibility must be involved in any right. The relinquishment by the Powers of treaty guarantees which are of great material value to them, and which they have so long enjoyed, rests on the implicit belief that China will not make use of her new position to modify her customs tariff in such a way as to hamper or to destroy her foreign trade. I feel confident that China will live up to her moral responsibility and prove herself equal to the trust thus placed in her by the Powers.
>
> The proposed agreement with China also provides for reciprocal engagements to maintain specified rates of duty upon a number of commodities for certain periods of time. What we naturally desire is the stability of our trade with China. We cannot be expected to remain indifferent to frequent and radical changes in the Chinese tariff. China on her part finds it equally important to secure a market in Japan for certain classes of Chinese manufactures. These mutual desires have given rise to a scheme of reciprocal undertakings in regard to customs tariffs. The arrangement marks a step forward towards the full realization of the principle of solidarity between Japan and China, and is but a natural outcome of the specially close economic relations existing between the two nations. Needless to say, it does not in any way infringe upon the customs autonomy of either nation. On the contrary, it is nothing more than a normal exercise of State sovereignty.

> We further propose, in accordance with our settled policy, to proceed to the discussion with the Chinese Government of other provisions to be incorporated in a new Commercial Treaty, besides those which relate to customs duties. It is sincerely hoped that through mutual appreciation by each nation of the just and reasonable position of the other, satisfactory progress will be assured for these negotiations.
>
> It appears that recently, along with the re-appearance of signs of unrest on the political horizon of China, a section of the press in that country has been disseminating reports, suggesting that we had a hand in bringing about that turn of events and were engaged in the prosecution of unworthy designs. Such accusations are too preposterous to call for any denial. It cannot be necessary to reaffirm our known policy of fair and square dealing in China.

The annexe to the Sino-Japanese Tariff Treaty which has attracted considerable attention and criticism in China is that dealing with the undertaking of the National Government to repay outstanding defaulted obligations. This question looms particularly large as China is faced with the necessity of going into the markets of the world first to revive and then to develop a national credit. China's national credit is at this moment lower than it has ever been in the history of the country. It is not only not possible for the Government to borrow in the international money markets, but merchant credits are frozen and industrial credits reflect the general unwillingness to make advances to firms whose credit, in international markets, cannot be better than the credit of the country of which they are a part. The result is that the national Government is unable to obtain funds for reconstruction and currency reform and railway building, while private organizations are unable to find capital for the creation and fruition of a national industry.

The total indebtedness of China, to Chinese and foreign creditors, is about $3,000,000,000 Chinese currency, of which about one half is in default. A method must be found to liquidate this huge indebtedness, so that new credits may be evolved. But even more important, at the present stage of developments, is the necessity of assuring the world that it is the intention of China to meet these obligations when she can pay and that a sincere effort will be put forth to find a method of meeting these obligations. Mr. T. V. Soong stressed this necessity in the annual report of the Ministry of Finance. The fact that Japan is one of China's principal creditors makes it altogether fitting that this intention of the National Government should be included in a treaty between China and Japan.

The amount of the defaulted indebtedness is indubitably subject to readjustment. Some of the obligations and particularly some of the interest factors are hardly able to stand the test of public scrutiny. It is, however, not possible for a debtor alone to determine which of the obligations he will recognize ; this can only be accomplished advantageously to the national credit by the mutual endeavors of the creditors and the debtors and the proposed conference for the readjustment of debts will undoubtedly serve as the means for reducing China's defaulted indebtedness and at the same time of restoring China's credit. When the Legislative Yuan recently passed a resolution stating which kinds of debts were not to be recognized, it committed a tactical blunder, for it raised a doubt in the minds of creditors of the *bona fides* of the Government's intentions. It is to be assumed, however, that such was not the intention of the Legislative Yuan. Rather was theirs a gesture of caution based upon legalistic and constitutional grounds that Executive officials should not in the future enter upon engagements without consulting them somewhat in advance, lest they be forced to make serious changes when the public document comes before them for scrutiny previous to ratifications. In accordance with the system of Government prevailing in China at the present time, the Legislative Yuan is quite within its rights and the slight flurry occasioned by the strictures over the Sino-Japanese Tariff Treaty need not be regarded as a recrudescence of Anti-Japonism nor even a criticism of the Minister of Foreign Affairs of China but a mere assertion of a right which is established in law but not yet altogether in practice.

The final ratification of the Sino-Japanese Tariff Treaty by both Japan and China marks the end of anti-Japanese agitations in China. It is the beginning of a new era of friendly intercourse. This novel condition does not arise from the mere treaty but rather from the spirit evident during the negotiations and the desire on the part of the best elements of both people that a way to peace and friendship should be found. The Treaty becomes a symbol of that desire and that accomplishment. It will be followed by other manifestations of good-will on both sides. It will be followed in particular by the cultural co-operations between the two countries through the expenditure of the Japanese share of the Boxer Indemnity for cultural research in China. It will find its happiest expression in the renewed and increased trade between the two countries, so that Japan can partake of the benefits of a stabilized China, which Japanese sacrifices in possible immediate gains for uncertain future considerations, will assure.

The British Boxer Indemnity and the Railways of China

THE decision of the British Government to allocate two-thirds of the British Boxer Indemnity for railway purposes in China has aroused considerable pleasure among the Chinese, who feel that this is a constructive use of the money. It is true that many Chinese sought these funds for numerous educational, charitable and what might aptly be termed miscellaneous projects, but the Ministry of Railways insisted upon its constructive program and its desires in the matter were respected by the British Government. The measure is not only wise for China but wise for Great Britain. China will probably be able to complete the Canton-Hankow Railway, Britain will be able to sell to the Ministry of Railways additional steel rails, locomotives, cars and other railway supplies. To British trade in China, the allocation of these funds for railway purposes, means a tremendous relief from the general trade stagnation which is the result of political conditions which have heretofore impeded the development of Mr. Sun Fo's railway development program and the advice of Mr. Poland and Mr. Mantell that the existing railways be thoroughly rehabilitated. Mr. Sun Fo's program would find China with additional mileage, her railways in an efficient, modern working condition and business booming because of the additional trade from the purchase of railway materials. Only the civil war has prevented this program from being completely realized and the first relief in an otherwise gloomy picture is the announcement of the availability of the British share of the Boxer Indemnity for railway purposes.

As far back as February, 1924, *The Far Eastern Review* advocated the use of the Boxer Indemnity for railway purposes. At a time when it was everywhere advocated that Boxer Indemnity funds should be spent exclusively for exceedingly uncertain cultural purposes, *The Far Eastern Review* was practically alone in raising the question of the use of these funds for railway purposes. In July, 1924, Mr. George Bronson Rea, its editor, advocated the use of the unpaid American portion of the Indemnity for the building of the Szechuan railway. That may not altogether have been practicable, but the essential idea that the physical basis of the Chinese people must be changed before there can be stability and genuine progress in the country and that that physical basis is dependent upon the modernization of the means of communications, has generally been accepted by the best thinkers in China. A country the size of China with only 7,000 miles of railways cannot hope to find peace or stability ; no army can move about with sufficient rapidity to put down banditry and insurrection ; the peasants cannot get their produce to ports with sufficient rapidity to be real factors in the markets of the world ; manufactured goods move from seaboard ports to interior cities so slowly and at such a terrific cost that the people cannot afford to purchase them. The backwardness of China does not involve any inherent inability of the Chinese people. It is due to a lack of modern means of communications. This has been the central idea of the policy of *The Far Eastern Review* for a quarter of a century——we continue to advocate the same policy—build railways and more railways until China possesses just such a network as Dr. Sun Yat-sen's map of his projected railways indicated. Then there will be no backwardness in China.

In the October, 1924 issue of *The Far Eastern Review*, a survey was made of the three points of view on this subject: the American, the British and the Chinese. It was with pleasure that we noted at that time that British opinion was beginning to favor the utilization of Boxer Indemnity funds for railway purposes. It was perfectly evident that as the British traders sought to restore British markets after the War, there could be no better introductory method that the employment of Boxer Indemnity Money for railway purposes in China. It was then advocated that the interests on the funds invested in railways should be used for educational purposes, thus accomplishing two tasks by the means of one fund which would be permanently invested in a sound security while educational institutions would, in effect, be endowed by their ownership of railway bonds.

This plan fell through largely because of the turmoil which began in the year 1924 and continued for several years thereafter. It will be remembered that the British Government sent a Commission to China, headed by Lord Willingdon, now Governor-General of Canada, to study the problem of the return to China of the remaining British portion of the Boxer Indemnity. On this Commission were three Chinese, Dr. Hu Shih who has long advocated changing the physical basis of the life of the Chinese people, Dr. C. C. Wang, who had been Managing-Director of the Chinese Eastern Railway and is one of the foremost railway engineers in China, and Dr. V. K. Ting, the greatest geologist and scientific thinker in the country. This Commission reported as follows:

"The delegation unanimously recommend that the most profitable form of work of outstanding national importance, and an enterprise which could be counted upon to confer a real benefit on large numbers of Chinese people, would be the extension of railways."

The Commission finally recommended the linking up of the trunk-line of the Hankow-Canton Railway as "the most suitable and the most useful project which could be adopted."

It is with much gratification that *The Far Eastern Review* points to its own part in the genesis of this idea, not so much as a matter of self-glorification but because at the time, opinion was so generally concentrated upon cultural work that little thought was given to the possibility of employing these funds on a railway, except in this engineering paper in which there would naturally be a keener interest in the engineering phases of any project. The future of China depends upon the building of railways—peace and prosperity can only come with adequate means of communications. This is the corner-stone of our political policy as regards China.

The National Construction Commission

PARTICULAR interest will be shown by engineers in the work of the National Construction Commission, the chairman of which is Mr. Chang Ching-kiang, a prominent Nationalist leader who is concurrently Chairman of the Provincial Government of Chekiang province. This Commission undertakes engineering activities on behalf of the National Government, its objects being enumerated as follows:

1. To study and plan constructive works throughout the country as enumerated in Dr. Sun's Plans for National Reconstruction.
2. To undertake works pertaining to water conservancy, electrical power developments and other governmental enterprises not belonging to the various ministries of the Government.
3. To direct and supervise private-owned electrical enterprises.
4. To undertake, with the consent of the ministries concerned such governmental enterprises as may come under their jurisdiction but have not been started by them.
5. To direct and supervise the works undertaken by the provincial Departments of Construction.

Much has already been accomplished by the Commission, particularly in the field of engineering. The most notable achievement was the development of a radio network, centering about the agreement with the Radio Corporation of the Philippines, a subsidiary of the Radio Corportation of America. The radio bureau of the Commission was organized in July, 1928, and within a period of six months was in control of 30 radio stations scattered throughout China. Many of these stations had been in existence for some years either as military or provincial stations, but to the Commission must go the credit for co-ordinating them into an efficient, working organization which is of service to the whole country and which is capable of permanent extensions. In accordance with the plans of the Government, this radio network has been turned over to the Ministry of Communications for operation now that it is organized. The National Construction Commission is in effect a planning and initiating body, which turns over to various Ministries agencies which rightly belong to them once the agencies are adequately organized.

In the field of electrification, the work of the Commission is most interesting. According to its figures, there are 575 electric light and power plants in China aggregating 527,240 KW. Of these companies, 17 are Government-owned, the remainder being owned by private capital. The Commission has the right to supervise the privately-owned plants which must register with it. Among the principal plants now being operated by the Commission are the Nanking Electric Works, the Tsishuyon plant between Wusih and Changchow and the Hangchow Electric Plant. The Nanking plant was a Government concern from its inception, although it has been very heavily mortgaged to American suppliers of electrical machinery; the other plants were privately-owned but have been taken over by the Commission on terms determined upon by the Commission.

There can be no question but that the Commission will serve a useful purpose in establishing and developing electricity plants throughout the country. There can also be no question but that the Commission will serve a most useful purpose in the supervision of privately-owned plants. There is, however, a danger in the Commission's tendency to force Government ownership even when private ownership has already been established. There is a danger that such a proposition involves elements of confiscation and that because of the uncertainty that comes to capital from such a tendency, capital, particularly foreign capital, will decline to permit itself to be employed in the electrical development of China. It is a remarkable fact that whereas at the present time, the coffers of the banks of Shanghai are so full of silver that they have produced a veritable glut of the white metal on the market, none of this cheap money is being used for the electrical development of China. If the Commission had not adopted so stringent a policy with regard to Government ownership, it may be assumed that large amounts of Chinese privately-owned capital would have been made available for the electrical industry. There are also reports in various places, that the Commission, in taking over old obligations, assumes that it alone may determine the terms of settlement and that the creditor must either accept these terms or leave them. This is an undoubted error from the standpoint of future credits and future developments.

We are not calling attention to these facts in a spirit of carping criticism. As an engineering journal, we are most enthusiastic over the work of the Commission and will do everything within our power to assist it and to help it to success. This is a fundamental work in the reconstruction of China, for without the modernization of the means of generating light and power, how can any phase of the life of the people be modernized. It is to be assumed that whatever controversies arose between the Commission and the owners of private capital in electrical enterprises, were due to the difficulties of the present situation in China and that in the future the Commission will adopt a policy which will permit the employment of private capital both Chinese and foreign. It will be quite impossible for any Government in China to finance the whole cost of electrical developments in China during the next decade. It would be impossible for any Government, because of the huge capital outlays required. It would be to the advantage of China to encourage privately owned enterprises on condition that they are adequately supervised.

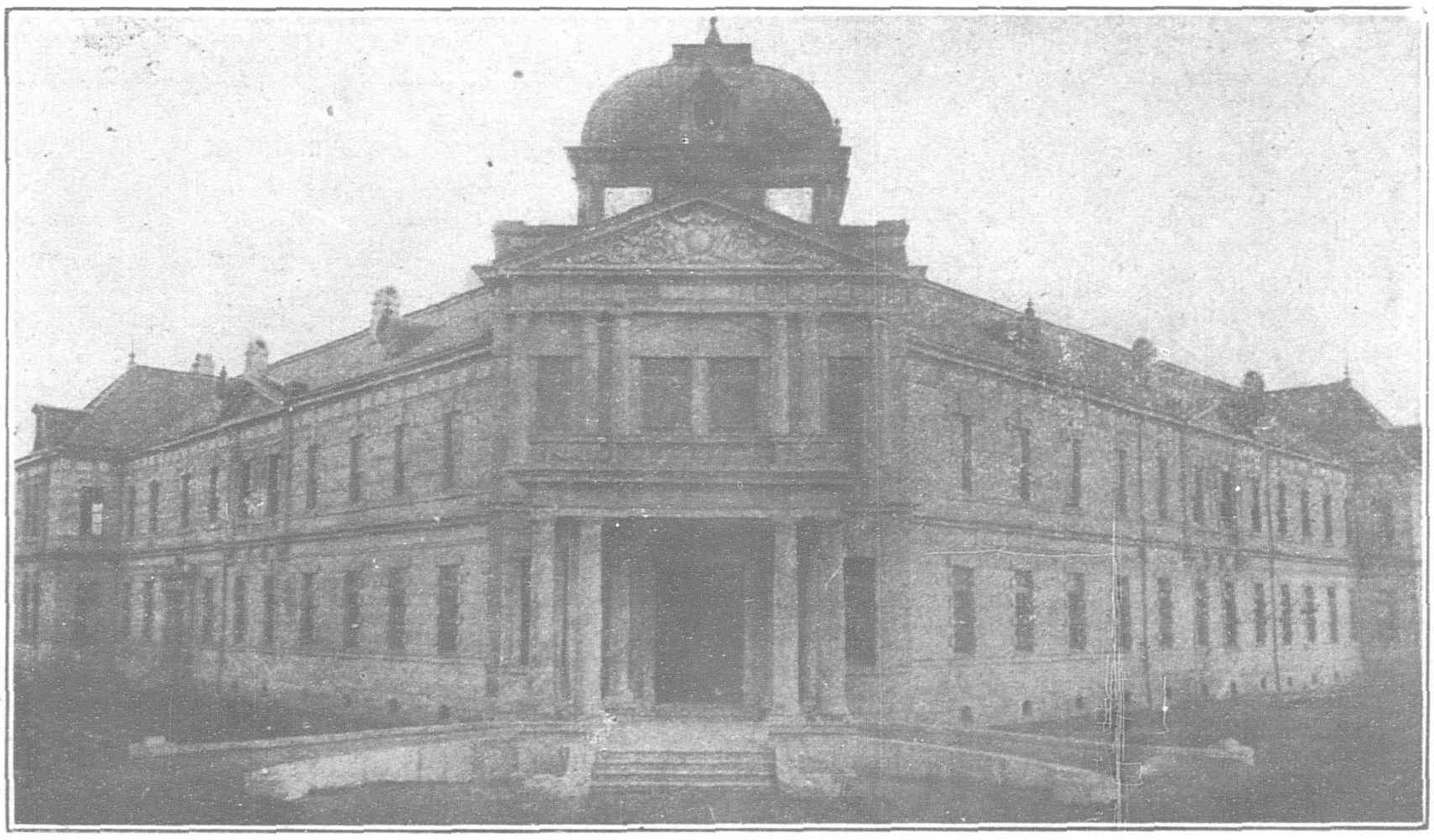
Japan's Colonizing Agency:

The Operations of the Oriental Development Company

Originally Limited to Chosen, Its Activities after 1917 Were Extended to Manchuria, China, and Southeastern Asia—Under Close Government Control—Bonds Sold in the United States

HERBERT M. BRATTER, Finance and Investment Division; United States Department of Commerce

The Oriental Development Co. (Ltd.), or Toyo Takushoku Kabushiki Kaisha, was established on October 8, 1908, under a 100-year charter, to engage in colonization work in Chosen. Its initial capital of Y.10,000,000 was one-quarter paid up. The Japanese Government, with the object of controlling the company, subscribed to 60,000 shares, which it still hold. Through this stock ownership, through the appointment of the president and directors, through the company's close relationship with the Deposits Bureau of the Finance Ministry, and through subscription to the company's debentures by the various special banks, governmental influence in the company's affairs is large.



Office Building of the Oriental Development Company at Seoul

As in the case of the special banks organized under Government auspices, the Government for the first few years guaranteed a 6 per cent, dividend on all Oriental Development Co. shares. Likewise it guaranteed unconditionally the two Oriental Development Co. loans floated in the United States in 1923 and 1928. Further strengthening the Government's influence, a law was passed in 1928 permitting the Oriental Development Co. to pay dividends on the Government-held shares at a rate 5 per cent lower than that paid other shareholders during the business years 1927 to 1931, inclusive. The Government, in accordance with the Oriental Development Company act—appoints special controllers, who examine the company's affairs.

The company is a steady borrower at the Deposits Bureau in Tokyo, receiving necessary capital from that source whenever conditions do not enable it to raise needed funds by the public flotation of debentures. In the past, when conditions have improved following credit granted by the Deposits Bureau, the Ministry of Finance has been known to suspend the unextended portion of such credits, as in 1924.

Raises Capital by Debenture Issues

A large part of the business of the Oriental Development Co. (Ltd.) resembles that of mortgage institutions in other countries. The company, by raising money through the public sale of its debentures, receiving deposits, and borrowing funds from the Deposits Bureau, was designed to assist in the development of Chosen. This was at first, and in now again, its chief business. The company not only makes loans, but also subscribes to private company shares and debentures.

The company's loans are extended to agriculturists, merchants, manufacturers, bankers, and municipalities, for irrigation drainage, construction, commercial, land settlement, and similar purposes. The company establishes and finances banks, trading posts, and agencies of various kinds. It engages in the development of water power. It may own, as well as improve, afforest, or settle land, The recruiting and distribution of immigrants in the various territories included in its sphere of operation is an important part of its business. It actively participates in agricultural corporations or banks formed to aid business in general and to supply settlers—as does the Oriental Development Co. itself—with agricultural implements, livestock, fertilizers, seed, and the like. Activities which the company at times has assisted with loans include alcoholic beverage manufacture, educational enterprises, the ceramic industry, marine products enterprises, fruit growing, stock raising, mining, paper manufacture, rice polishing, bean milling, cotton spinning, gas production, and miscellaneous undertakings. Through the Oriental Development Co. the Government has endeavored to stabilize the supply and price of rice in Chosen by developing sufficient rice fields to offset the general damage from drought.

Activities Defined in Articles of Association

Article 54 of the company's articles of association defines the loan activities of the Oriental Development Co., which are summarized as follows in a survey prepared by the company:

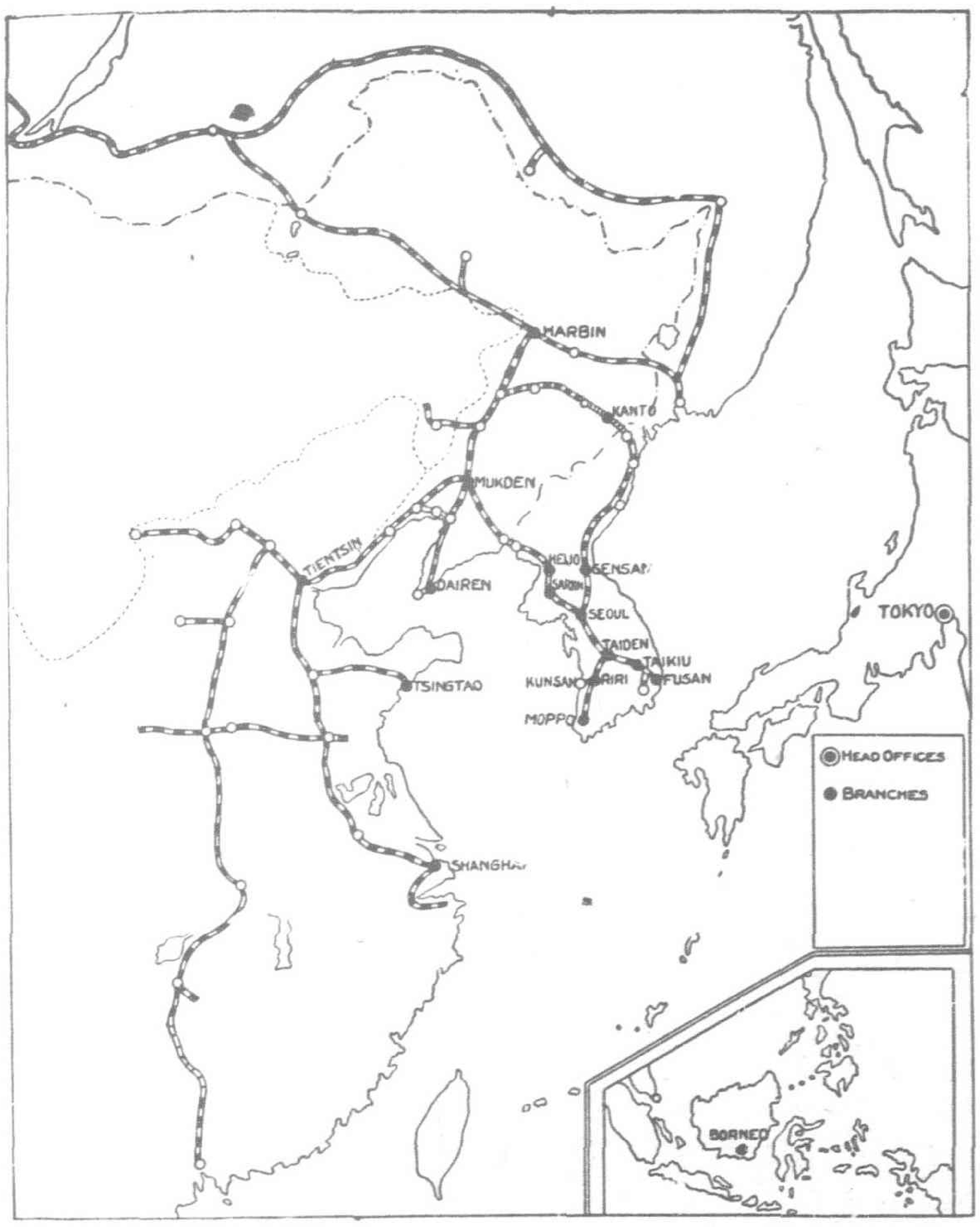
(1) To make loans to immigrants for immigration expenses, to be redeemed in annual installments within 25 years or at fixed times within 5 years.

(2) To make loans to producers on the security of their produce, for a period of less than 1 year.

(3) To make loans on the security of immovables, railways, mining rights, and other rights on immovables, to be redeemed in annual installments within 30 years, or at fixed times within 5 years.

(4) To make loans without security to public bodies or industrial associations organized by virtue of special laws, to be redeemed in annual installments within 30 years, or at fixed times within 5 years.

Map Showing the Field of Operation of the Oriental Development Co., Ltd.



(5) To make loans without security to farmers, not less than 20 in number, bound by a joint obligation, to be redeemed at fixed times within 5 years.

(6) To subscribe for or underwrite shares or debentures issued by companies engaged in the handling of immigrants or in undertakings for local development.

(7) To make loans on the security of shares and debentures issued by companies engaged in the handling of immigrants or in undertakings for local development, to be redeemed at fixed times within 5 years.

(8) To make loans on the security of the " mass of properties" (zaidan) created by virtue of laws or ordinances, or on other reliable security, to be redeemed in annual installments within 30 years, or at fixed times within 5 years.

Development Operations in Chosen

The developmental work in Chosen consists of aiding companies with objects similar to its own ; in encouraging and improving agriculture, afforestation, and immigration ; and, particularly, reclaiming and developing idle land. This work is aided by the company's ownership of land, which it rents to tenant farmers. This land consists of rice fields and forest and other areas received from the Government in payment for shares in the company. In Manchuria the company does no work of this character. In Kwantung since 1921 it has been engaged in salt manufacture.

Land is not only one of the company's principal assets, but also one of the most profitable. In 1926 it was reported that 12 per cent return was earned on the land holdings, valued at Y. 16,000,000. In 1928-29 income from lands amounted to Y.4,700,000 being exceeded only by income from loans.

In addition to 64,420 acres of forest land owned by the Oriental Development Co. in Chosen, it had under lease 138,376 acres of state lands devoted to forestry. Afforestation was begun by the company as early as 1910. By March 31, 1928, 242,000,000 trees had been planted.

Operations Outside of Chosen—Immigration

Since July, 1917, the Oriental Development Co. has operated also in Manchuria, Mongolia, China proper, the Straits Settlements, and the islands of the South Seas, where it has interests in sugar plantations. In Manchuria the company of late has replaced the Bank of Chosen in making loans against Japanese-owned property.

In 1924, when the larger part of the company's Y.152,000,000 advances was said to be outstanding in Manchuria, it was annuounced that its activities outside of Chosen would be reduced, and figures for the first half of 1926, accordingly, showed loans of Y.142,800,000-68,600,000 in Manchuria, 54,800,000 in Chosen, and the remainder in North China and Taiwan. By the end of 1926 loans in Chosen exceeded those in Manchuria. Nearly half of the loans in Manchuria in 1926 went for urban undertakings and the remainder for maufacturing and transportation enterprises. In Chosen most of the advances in 1926 were for agricultural purposes.

From 1910 to March 31, 1929, the company had encouraged 3,971 Japanese families to settle in Chosen. Such settlers usually are given 2 cho (nearly 5 acres) of the company's land, although some receive 5 cho, for which they pay one-quarter of the value of the land. The settlers are brought into Chosen only in times of special need, as when the reclamation of waste land is undertaken.

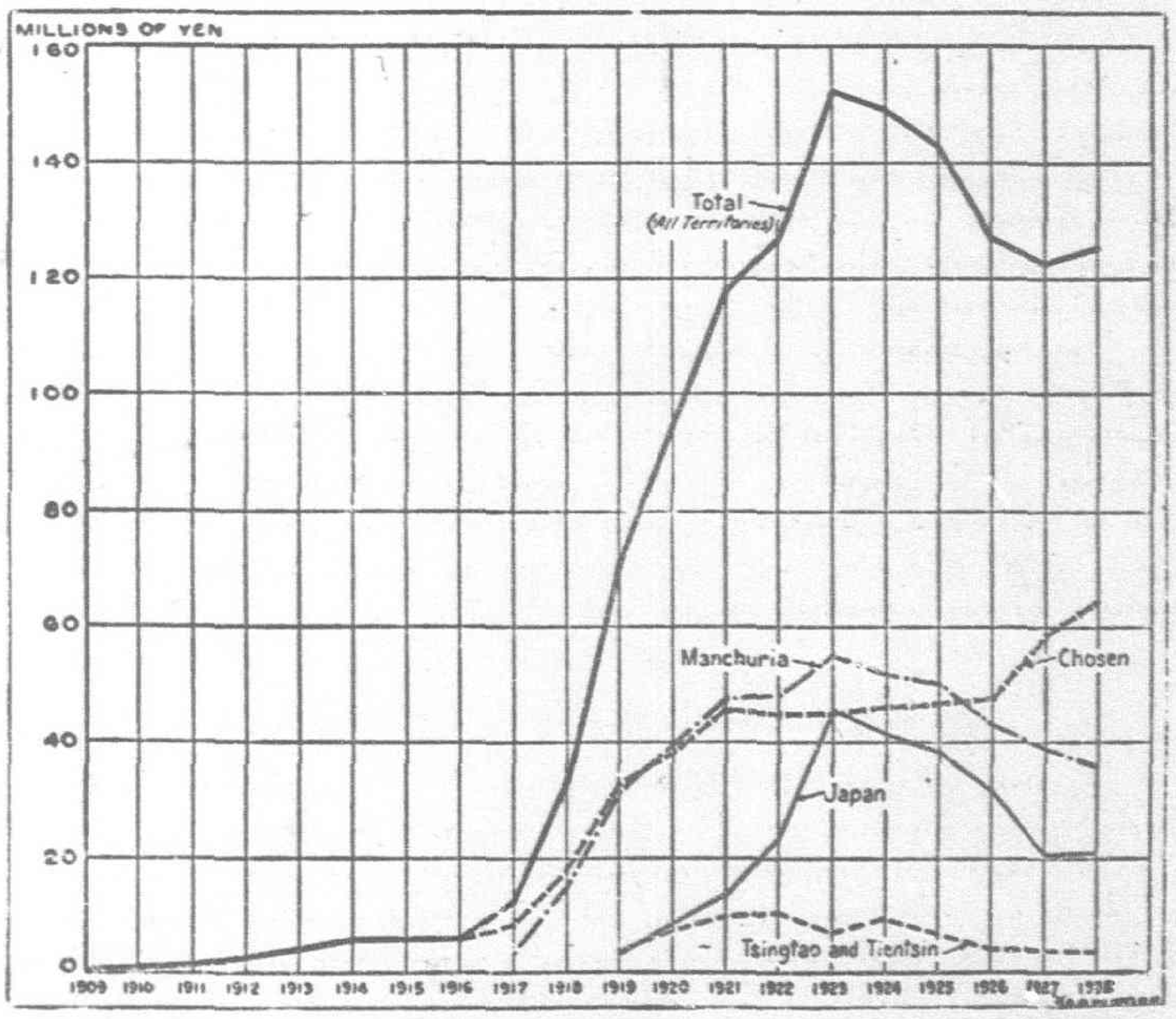
Geographical Distribution of Loans

The accompanying graph shows the geographical distribution of the loans of the Oriental Development Co. since 1909. The total, it will be noted, reached its peak in 1923, declining thereafter until 1927, when an upward trend appears again to have begun. Loans in Chosen comprised practically the entire total up to 1917, when activities were inaugurated in Manchuria. By 1919, loans in Manchuria were almost as great as in Chosen, and subsequently became the most important group until 1926.

The company's loans in Japan proper were first recorded in 1919. They attained their maximum in 1923, in which year they slightly exceeded loans in Chosen, declining sharply thereafter, but registered a slight increase in 1928.

Investments in Shares and Debentures

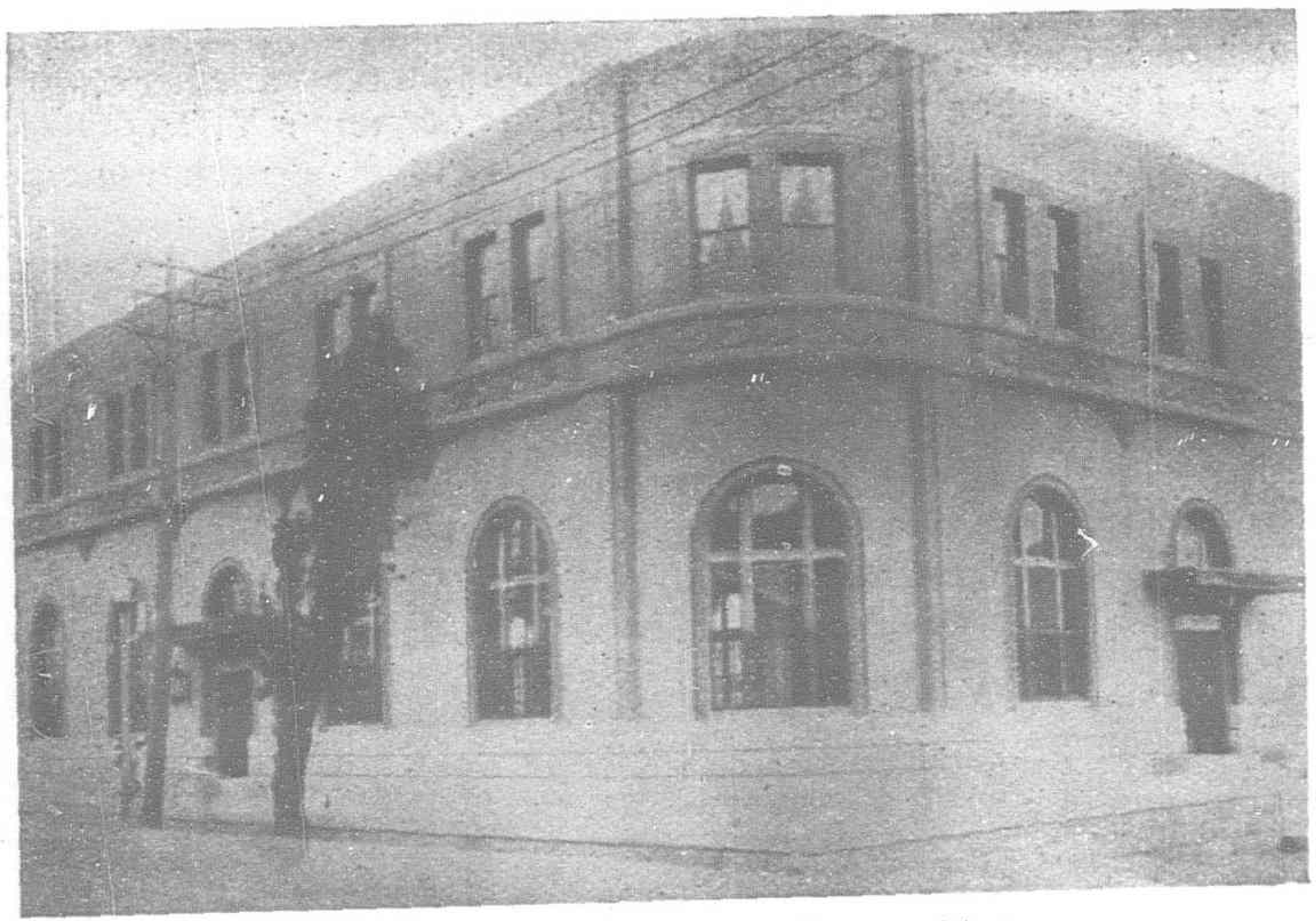
The changes introduced in 1917 in the operations of the company not only extended the field of activities into Manchuria and China, but also enlarged their scope. Whereas, previously, the company's investments in securities were confined to agricultural and industrial debentures in Chosen, since 1917 it has been permitted to purchase shares and debentures of companies handling



Geographical Distribution of Loans of Oriental Development Co., 1909 to 1928 immigrants or engaged in developmental work, either in Chosen or elsewhere. On March 31, 1929, the Oriental Development Co. held 421,796 shares in 21 companies. These shares had a paid-in value of Y.9.685,900. On the same date the company held Y. 8,390,000 of debentures—the issues of six companies—and Y. 3,820,000 of matured and local loan bonds.

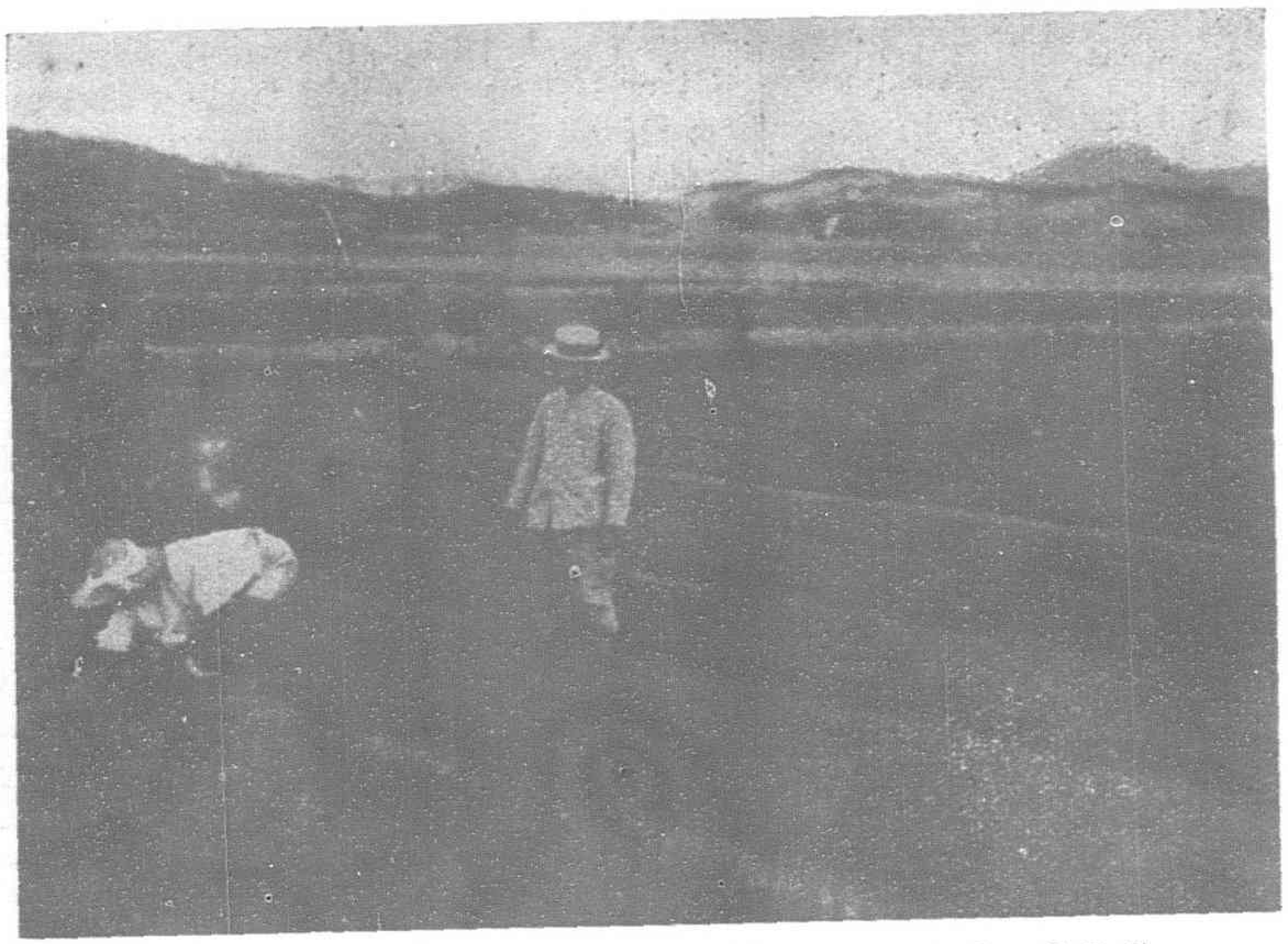
Debenture Issues Outstanding in 1929

The company is permitted to issue debentures to 10 times its paid-up capital, and up to the end of March, 1929, had issued them on 58 occasions. On that date such securities outstanding totaled Y.176,730,632 representing 40 separate issues. The largest of these



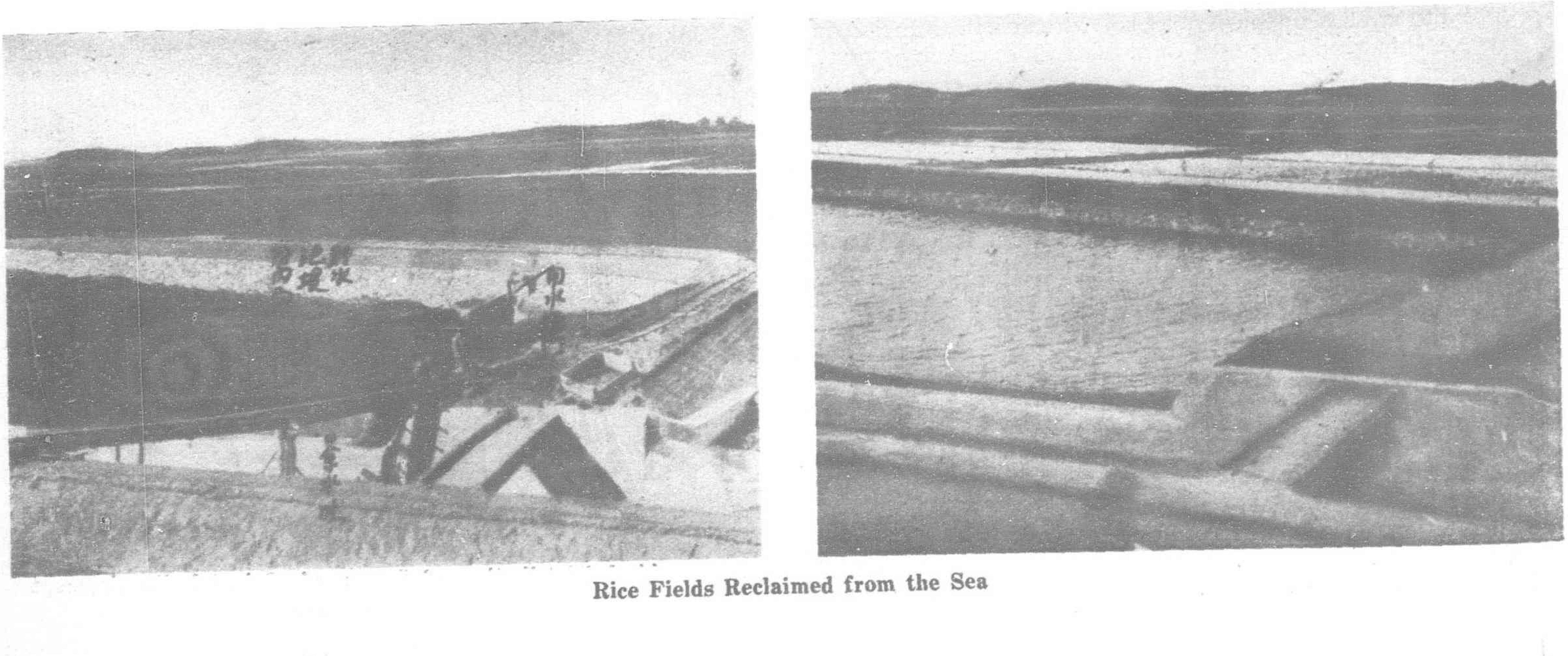
O.D.C. Branch Office at Fusan, Korea

Forest Planted by the O.D.C. Average Life of Trees, 11 Years



Rice Nurseries Cultivated by Tenants of the O.D.C.

Conditions of other Korean Rice Nurseries



Rice Fields Reclaimed from the Sea

Head Office of the Oriental Development Company, Tokyo

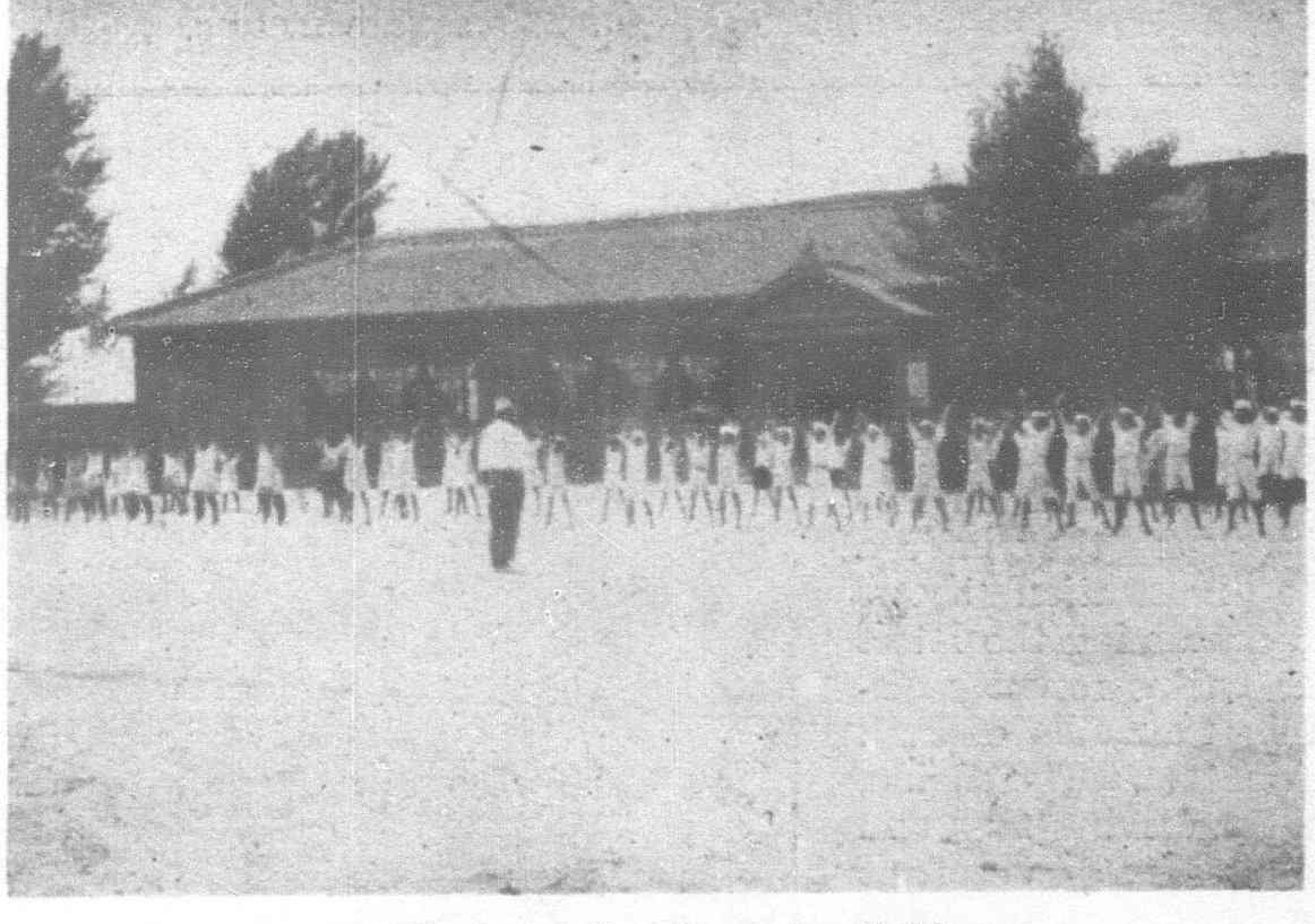
issues, in original amount, were the two $19,900,000 loans floated in the United States in 1923 and 1928. Of the domestic issues, the largest in original amount and in amount outstanding in 1929 was the fifty-third, a Y.15,000,000 loan floated in March, 1928. Debentures outstanding on March 31, 1929, equaled approximately five times the company's paid-up capital. By a special provision inserted in the act creating the company, holders of its debentures have a preferential claim to the company's assets over any other creditors. The Japanese Government, furthermore, may guarantee payment of both principal and interest of any of the company's debentures.

Government-Guaranteed Dollar Loans

The Oriental Development Co. was the first Japanese interest to place a dollar loan in the United States with a Japanese Government guarantee. The loan, amounting to $19,900,000 and bearing interest at 6 per cent, was offered to the public on March 15, 1923, at 92, to mature in 30 years. On November 1, 1928, a similar issue of $19,900,000 of 30-year debentures was offered in the United States at 90. This loan was raised to retire outstanding yen debentures of the company to a total principal amount of $11,521,230 the balance being for the payment of bank loans. Interest on this issue was at 5½ per cent. Like its predecessor, it was guaranteed by the Japanese Government.

Business Affected by 1920 and 1927 Depressions

The company, in common with other Japanese interests, suffered from the depression of 1920-21, but, nevertheless, continued to pay more than the usual dividends. From 1921 to 1923, inclusive, shareholders received 10 per cent. the highest dividend ever paid by the company. In 1923, the year of the earthquake, dividends were lowered to 8 per cent, but the effects of the 1920 depression continued to be felt down to 1927. In March of that year the Ministry of Finance recommended that the company reduce its dividend to private stockholders. This recommendation subsequently was adopted. Shortly thereafter the Ministry of Finance announced plans for the assistance of the Oriental Development Co. These included a 2 per cent. reduction of the interest rate on its loans to the company and practically a non-dividend basis for the Government owned shares.



A School for Immigrant's Children

On May 21, 1927, a general meeting of the stockholders drew up a readjustment plan for presentation to the Diet. The principal items of the plan, which was in keeping with the Finance Ministry's suggestions, were:

Doubtful account and unsound assets amounting to Y. 20,834,000 to be written off as losses, of that amount, Y.14,929,331 to be covered by reappraisal of real estate, Y.348,383 by the previous balance carried forward, and Y.5,550,000 by the reserve for losses; the remainder being brought forward.

The Government to lower the average rate of interest on advances to 4 per cent. for the five following years.

The Government to forego dividend payments on its 60,000 shares so long as earnings continued insufficient to pay 5 per cent. on all non-governmental shares.

Growth of the Company and Earnings

The estimated net earnings of the Oriental Development Co., as given in the *London Stock Exchange Gazette*, increased from $520,923 in 1913 to over $7,300,000 in 1923. Earnings for the five following years, converted on the basis of yearly averages of monthly quotations for yen exchange, were reported in a circular describing one of the company's issues, as follows:

Earnings of the Oriental Development Co. (Ltd.)

[Figures in United States dollars, reduced to the nearest 100,000]

Year ending March 31	Exchange rate	Gross earnings	Operating expenses	Net earnings	Interest payments	Available for sinking-fund reserves, depreciation, dividends and surplus
1924 ..	0.4754	11.1	2.5	8.6	6.1	2.5
1925 ..	.3997	9.4	1.6	7.8	4.8	3.0
1926 ..	.4240	9.8	1.7	8.1	5.4	2.7
1927 ..	.4810	9.4	1.7	7.7	*6.5	1.2
1928 ..	.4692	9.3	2.2	7.1	5.5	1.6

Capital and Funded Debt—Balance Sheet

The authorized capital of the Oriental Development Co. was increased to Y.50,000,000 in October, 1919. Of this amount Y.20,000,000 were fully paid up and 15,000,000 half paid up on August 31, 1928. The company's shares have a par value of Y. 50 (*The Japan Weekly Chronicle* of February 28, 1929, however, reported that the company planned to reduce its capital from Y.20,000,000 [5,000,000 paid up] to Y.10,000,000.)

Besides capital obligations the company had outstanding on August 31, 1928, the following

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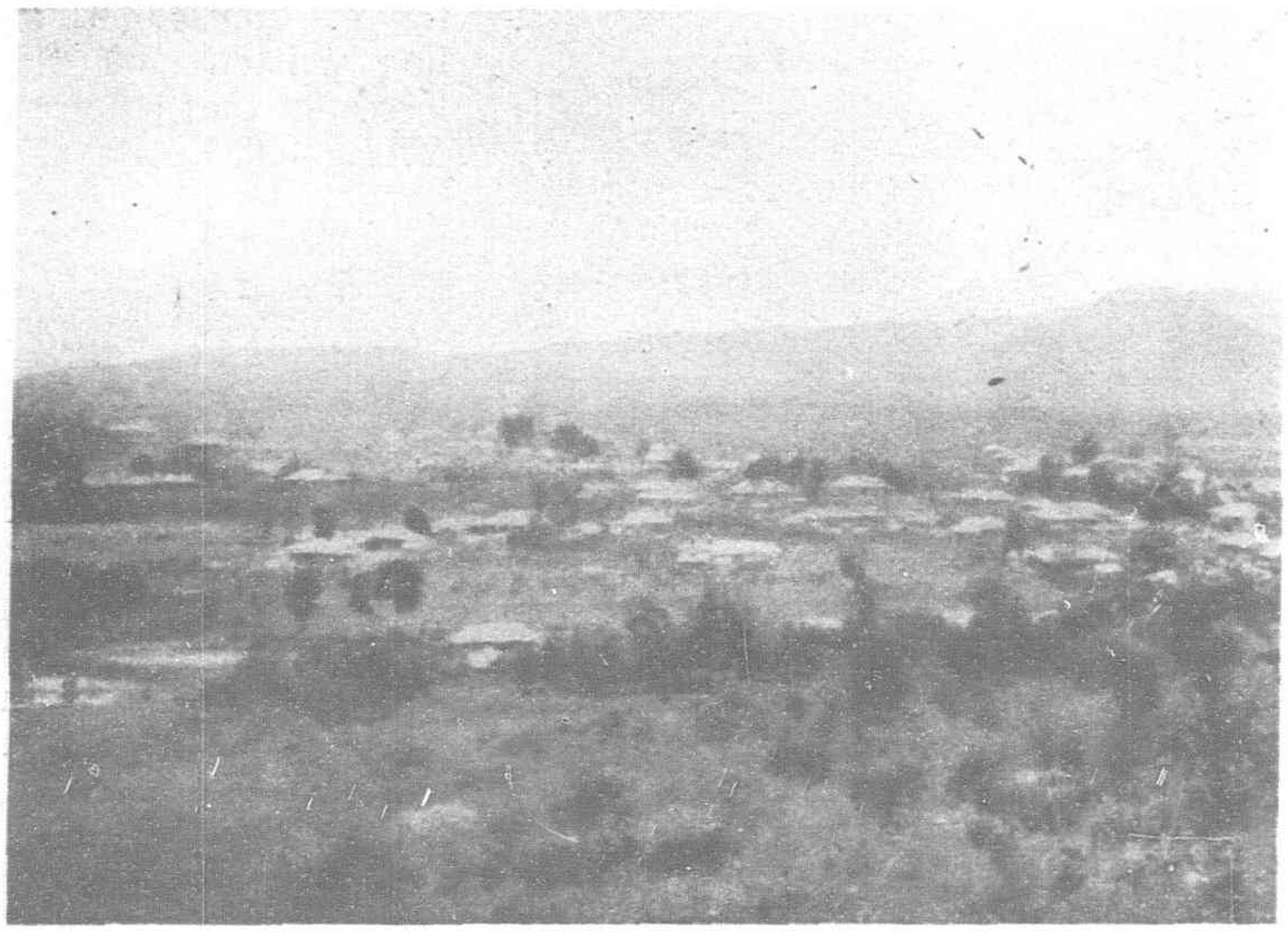
*Before adjustment of accounts whereby write-up of $6,469,450 in property account and transfer of $2,842,414 from reserve fund were added to income, and extraordinary write-off and depreciation of $10,021,154 were deducted from income, after which adjustments $522,980 as per books, was available for sinking fund, depreciation, reserves, dividends, and surplus.



A Village of Immigrants of the Company

funded debt: External 6 per cent. debenture loan of 1923, $17,172,000; external 5½ per cent. debenture loan of 1928, $19,900,000; and internal debenture loans, Y.129,065,400. Only the two external loans bear the Japanese Government's guaranty. A French loan of 50,000,000 francs, issued in Paris in 1913 on a 5.22 per cent. basis, was repaid in 1924.

The balance sheet of the Oriental Development Co. (Ltd.), as of March 31, 1929, was as follows:

Balance sheet of the Oriental Development Co. (Ltd.) as of March 31, 1929

ASSETS:	Yen
Capital uncalled	15,000,000
Difference on securities	10,574,680
Loans	125,074,937
Loans made by company as agent	276,566
Stocks and other securities	17,952,929
Fund for special enterprises	10,095,609
Deposits	8,311,339
Money in special trust	23,459
Land	28,029,167
Forests	525,400
Buildings	6,467,897
Machinery and improvements	161,707
Farm products	953,817
Forest products	50,414
Industrial products	582,442
Land, buildings transferred to others	17,780,825
Articles loaned	485,985
Enterprises' account	3,077,494
Suspense account	1,694,050
Due on Toa industrial bonds sold	504,000
Bills receivable	600,232
Gold and silver	106,976
Total	*248,339,934
LIABILITIES:	Yen
Capital authorized	50,000,000
Reserve for losses	250,000
Reserve for averaging dividends	979,000
Securities outstanding	176,730,632
Fixed deposits	5,740,260
Money borrowed	2,803,702
Money in special trust	27,849
Land, buildings transferred	5,404,913
Suspense account	888,011
Exchange adjustment fund	1,277,425
Loans made by company as agent	276,566
Contract guarantee money	64,266
Surety money of personnel	396,401
Employees' retiring fund	334,380
Bills payable	847,605
Branches	868
Gold and silver bar account	2,523
Balance carried forward from last term	372,371
Profits of the term	1,943,155
Total	*248,339,934

Branches at Home and Abroad

The head office of the Oriental Development Co. was transferred from Seoul to Tokyo in October, 1917, Branches and sub-branches were maintained at the following places in March, 1929: Chosen—Seoul, Fusan, Taikyu, Riri, Moppo, Taiden, Genzan, Shari-in, and Heijo; Manchuria—Mukden, Harbin, Dairen, Kanto; China—Tsingtao, Tientsin, Shanghai; and Dutch Borneo—Bandjermasin.

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*The summation of the assets is Y.248,339,925; that of the liabilities, Y.248,339,927. The difference between these two figures and the totals is no doubt due to the dropping of all fractional parts of yen.

New Freighter for D.E.I. Trade

Successful trials were run in February by the *Blinjoe* which was built by the Maas Shipbuilding Company for the account of the Konigkijke Paketvaart My., and intended for the carrying of freight in the Dutch East Indies. Her tonnage is 1,176 tons deadweight on a draft of 11 feet 9 inches.

Engines and boilers as well as auxiliary boiler and machinery have been constructed by Messrs. Stork Bros., and Company, of Hengelo, Holland. The main propelling engine is a Lentz double-compound poppet valve engine of the Lentz-Stork type with 2 h.p. cylinders of 370 mm., two i.p. cylinders of 800 mm., and stroke of 800 mm., developing at 110 revolutions per minute 1,000 i.h.p. Steam for main and auxiliary machinery is supplied by a Babcock & Wilcox water tube boiler, with a heating surface of 257 square metres under a pressure of 14 kg. per square centimetre. The boiler is equipped for coal firing with mechanical stoker of the underfeed type.

When the main boiler is not in use, during long periods in port, steam for the auxiliaries is supplied by a Cochrane boiler with a heating surface of 500 square feet and a pressure of 135 lbs per square inch.

Messrs. Stork have obtained orders for two further complete engines and boiler sets from the same owners for two more new vessels. The main engines will be a double compound Lentz-Stork poppet valve engine of 1,650 i.h.p. with steam supplied from two Babcock & Wilcox watertube boilers each with a heating surface of 232 square metres.

Crossley Gas Engine for Ceylon

Following their success at the 1929 Milan Fair, where they obtained first prizes in each of the six classes entered, the Crossley oil engines were awarded the Grand Prix at the recent Barcelona Exhibition. Their engines are well known in Asiatic countries where they have a long record for efficiency. The illustration shows an elephant hauling a 4½ ton case containing the latest type Crossley 85 B.H.P. suction gas engine recently dispatched to Ceylon for installation in the mills of J.H. Vavasseur & Company, Ltd., of Kurunegala. The engine, which is a repeat order, is supplied for driving fans and machinery for drying and producing dessicated cocoanut and will be supplied with gas from a gas plant using cocoanut shell charcoal as fuel.

Public Construction in Canton

By MILTON CHUN LEE

THE City of Canton may be rightly called the most up-to-date city of China to-day, when compared with other cities throughout the land. It is progressive, modern, prosperous and rich. It is the only city with modern conveniences, entirely constructed and controlled by Chinese. Of course, there are other cities in China with better modern conveniences but these cities are either totally or partially under the control of westerners, namely the foreign settlement in Shanghai as well as in most-treaty ports. The eastern suburb of Canton City is a residential district *par excellence*, comparing favorably with the Bubbling Well district of Shanghai, and having many modern up-to-date buildings and residences of the latest European and American designs. The writer, upon his return from the United States after some years of absence from his native city, was surprised to find the change that has been brought about there in a comparatively short space of time. One would take this eastern district for a fine American residential town. The commercial centers of Canton likewise show well in achievement and progress. Fine buildings are found all over the city and buildings of ten or more storeys high are common structures. The roads, too, are well paved with either asphalt or cement, the figures quoted elsewhere in this article sufficing to give one an idea of the progress made in road building in Canton. The object of this article is to discuss public construction of Canton under the following topics: firstly, the history of modern public construction in Canton, secondly, the scope and extent of road building in Canton, thirdly, the erection of public parks, and other public recreation grounds, fourthly, the public utilities of Canton, fifthly, construction of bridges and harbor improvements, sixthly, the construction of a model village, and finally, public construction as related to the improvement of public health.

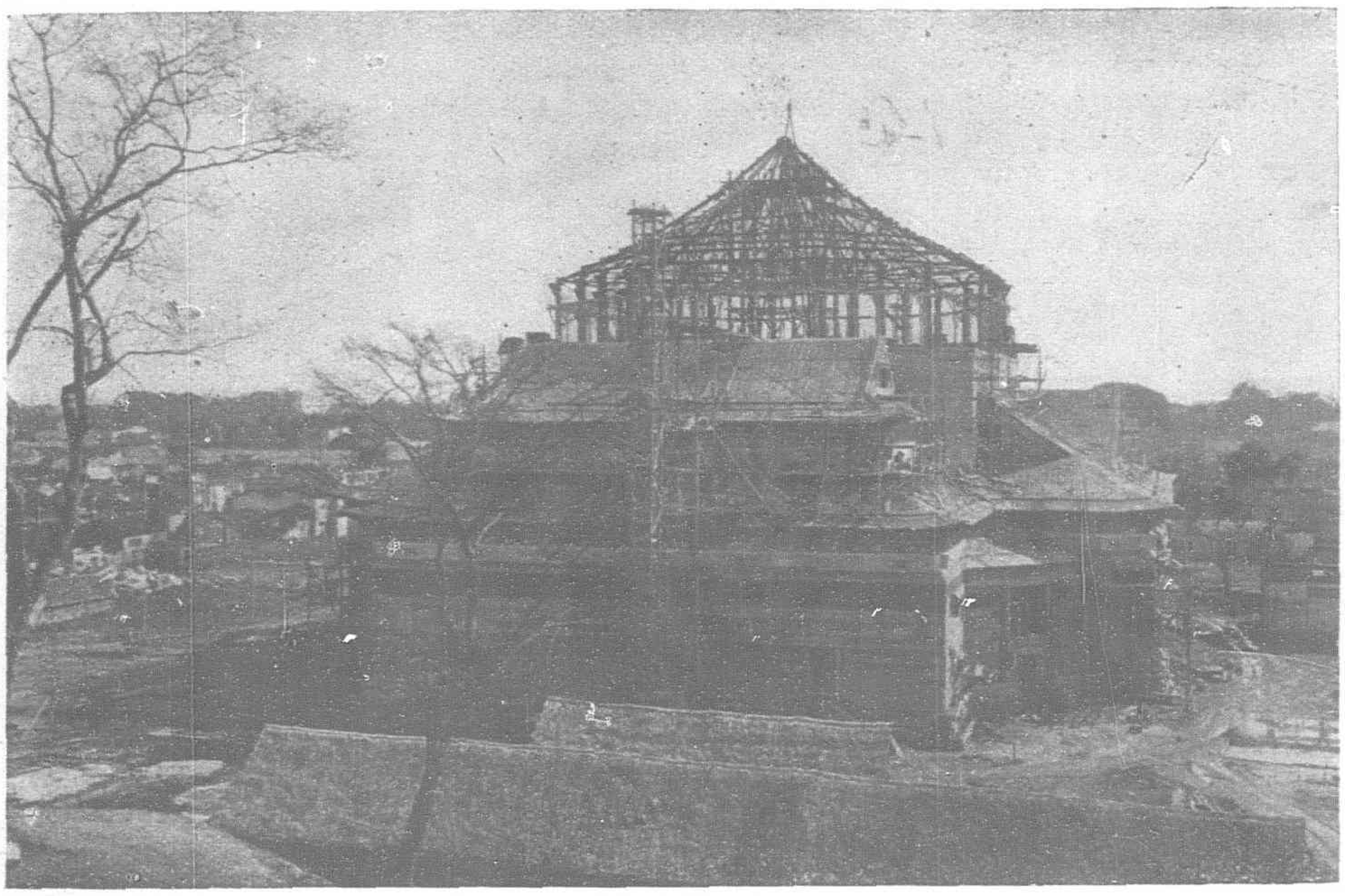
The Canton Bund

Canton is one of the oldest cities in China, covering a history of about two thousand years. It has, however, entered upon an epoch of municipal life only recently. Hitherto the city was absolutely in the hands of the power in being and was regarded as property of the Government and nothing more. Whatever improvement meted out for the city was made to provide better facilities for transportation of troops or other military uses.

Modern construction in Canton really started twenty years ago, when Governor Cheng Chun Shun ordered the erection of the Bund, along the bank of the Chukiang River. This was the first public construction of true importance. To-day the Bund is the principal

Yat-tak Maloo, Canton

Wing Hon Maloo



Progress on the Sun Yat-sen Memorial Hall, Canton

commercial thoroughfare in Canton, the most prosperous and the busiest.

The erection of the Bund was, nevertheless, a piece of work accredited to the Provincial Authority and not Municipal as there was no Municipal Government at that time. Soon, however, construction of roads and their repairs were undertaken by private individuals or groups. Streets were widened that were formerly exceedingly narrow and dirty and in some cases almost impassible. The year, 1918, particularly, marked a new era of municipal development. It was in that year that the city walls were demolished in the face of protests and despite strong opposition. A municipal bureau headed by a director was established to complete the tearing down of the walls, and the construction of a circular road on the course of the old barriers. But the program of public construction was not made until 1920. When the Canton Municipal Government was organized under the City Charter granted by the Provincial Government in 1921, Canton forged ahead to convert the old city into a modern metropolis. Beside the building of the circular road just spoken of, a number of narrow streets widened into good roads.

With the establishment of the Revolutionary Government in Canton more streets were given improvement that were centrally located in the city. Under the mayorships of Sun Fo and Dr. C. C. Wu, the building program further made progress. To-day one finds a network of roads connecting the various parts of the city. When the city was made the seat of the Nationalist Government in 1924 and the Northern Punitive Expedition vigorously pushed, the building of roads proved to be an urgent necessity to provide transportation facilities for the army.

During the strike of 1925, the strikers from Hongkong were employed for the construction of roads in the city and of the Chung Shan Road to Whangpu from the city a distance of about five miles. The Chung Shan Road follows and runs parallel to the track of the Canton Kowloon Railway almost all the way. Though it was built rather in haste, it was fairly well constructed. To-day one can motor out to Whangpu from Canton in less than an hour.

The immense progress in public construction, especially that of roads, made by Canton in recent years, may be best pictured by an eminent observer, who said: "The narrow streets, barely wide enough for a couple of sedan chairs to pass abreast, had given way to fifty miles of well-laid, well-paved, and well-drained thoroughfares. Fine buildings have gone up, and extraordinary care is taken not to waste the valuable frontages along the new streets. There is even a 'sky-scraper' of ten storeys high, (the Dia Sun Department Store). The whole aspect of transport in the city had changed, and now the call of the chair coolie working his way through congested alleys had been replaced by the honk of the motor-horn."

From 1924 to 1929 Canton experienced a period of rapid development and progress. What it has accomplished in these short annals is told in the sections following.

The area of Canton City itself is about eight and a half square miles, while that of the projected "Greater Canton" is approximately 67 square miles. Since the organization of the Municipal Government in 1920, Canton has built approximately two hundred and fifty thousand feet of modern roads, about fifty per cent. of which was built after the launching of the Northern Punitive Expedition. Of these roads, 53,000 feet are paved with asphalt, 85,000 feet cement, and the rest sand-and-stone mixture. The width of these roads varies from 100 feet to thirty feet. the widest being the Model Road, which consists of two side drive ways, one main drive way, two rows of trees and two side walks. Wing Hon Road, too, is very broad and is paved with asphalt, which makes it the best road in the central commercial section of the city. The "Wall Street" of Canton, that is, the Sap Sam Hong, the old foreign hong section before the opening up of Shameen as a "foreign concession," as well as Sap Pa Po, the western commercial district, both have good roads. On the whole the important commercial and residential sections in Canton have roads paved with asphalt, which eliminates both noise and dust. These roads compare favorably with those of the foreign settlement in Shanghai or even those of American cities.

The Canton Municipal Government under the efficient administration of Mayor Lam Wan Kai is now carrying out an

The Water Tower, Tungshan, Canton

extensive road building program, the total length exceeding twenty thousand feet. In fact the municipality is not only constructing and widening streets in various sections of the city, it has also tarred something like fifty thousand feet of the surface of the roads with macadamite to prevent dust and wear, and to keep the roads always in good condition.

With the restoration of peace and prosperity in the province of Kwangtung, Canton again forges ahead in its road building program. A scheme for the construction of 61 modern roads beside those already mentioned has been decided and outlined by the Canton City Road Construction Bureau. The work is to be undertaken in three stages. The first covers 22 new roads of 90,090 feet, costing $3,603,600, the second 20 roads, of 72,000 feet, costing $2,893,600 and the third, 19 roads of 79,330 feet costing $3,170,000 The total expenditure amounts to nearly $10,000,000. When this scheme is completed the central portions of the city will be linked with the various suburbs and the City of Canton will be entirely modernized.

The most important public utilities in Canton are no doubt, the electricity, the telephone, and the water supply. Though they constitute daily necessities of life, they are far from being satisfactory. In fact a common saying in Canton is this: "Electric light not bright, water not clean, and telephone not clear." The three "nots" aptly describe the conditions of the principal public utilities in Canton. The Canton Municipal Government, however, has lost no time in remedying conditions and steps are being taken to regulate and control the enterprises and to effect government ownership and operation if necessary. A hydro-electric plant has been put up and is being operated by private individuals under government supervision. The plant is too small to supply adequately the present demand of the city. If any breakdown occurs in any part of the machinery of the plant, the entire city is plunged into darkness. According to a late report from the southern metropolis, the Municipal Government may be forced to take over control and operation of the electricity plant to insure better administration and therefore a more adequate supply of electricity in Canton. However, seeing that such a step may upset the present order of things the Municipal Government of Canton seems at present to be satisfied with mere regulation and supervision.

With regard to the water works of the city, the Government has also taken definite measures to improve the service. For one thing, the Canton Water works is definitely at present a government enterprise. This public utility under private control proved to be an utter failure. The water supply was not only insufficient but not wholesome. Government ownership was therefore the way out of the difficulty. In fact under the Municipal Government, a water tower has been constructed in Tung-shan, the eastern residential district of the city. Previously this section of the city was never able to get any water supply at all as it is situated on a height, while the water works are built in the river valley in the western suburb of the city. Since the completion of the water tower in Tung-shan, the inhabitants of the district are blessed with unending supply of water, and heap praises of far-sightedness upon the City Government of Canton.

Recently Dr. Wu Pak-liang Commissioner of the Canton Municipal Water Works has signed a contract with a well-known British firm on behalf of the Municipal Government of Canton, for the building of a plant effecting rapid filtration and treatment of water at the rate of 10,000,000 gallons per hour. The general method adopted of preparing good water is by treating the raw water with lime and coagulents, passing it to settling tanks and then filtering it through rapid gravity sand filters constructed of ferro-concrete and filled with graded sand through which the water circulates at the rate of eighty gallons per square foot of filtering surface per hour. The water is then treated by the "choloronome" process, which adds continually about one part of chlorine gas to 2,000,000 parts of water, giving complete sterilization without leaving any trace of taste or smell. The raw water in Canton will be supplied from the Canton River, about six miles from the city, and pumped to the filters by means of three electrically driven low-lift pumps, each capable of handling 5,000,000 gallons per hour, one pump being a spare. There will be a battery of sixteen of these filters. The total cost of the whole equipment, including pumps, pipes, and other accessories, is approximately 250,000 Hongkong dollars. When this scheme is completed, the City of Canton will have a water supply equal in efficiency to that of the cities of Europe or America.

The next important construction in public utilities was the erection of the automatic telephone system in Canton. The idea of installing the automatic system was sponsored by Ex-Mayor Sun Fo, who signed a contract with the American Automatic Telephone Company. The contract, though signed, never took effect and for a time the project was shelved. At the beginning of 1928 the Canton Municipal Government signed a contract with the China Electric Company for the installation of a Rotary Automatic Telephone System in the city. The contract stipulated that the company should be responsible for the construction of an exchange, the laying of the wire system, most part of which is underground, and the supply of all necessary materials, equipments, machinery, etc. The exchange has a capacity for 4,000 lines, can be extended to 10,000 lines, and has a future extension capacity of 40-50 thousand lines. After about a year's work the company completed the project, and now many thousands of automatic telephones are in use for numerous homes and business houses in Canton. The cost of constructing the system was $690,000 gold.

It may be of interest to note that the telephone system of Canton not only serves Canton Proper, but also half a dozen of suburban centers around Canton, namely, Honan, the city opposite Canton, Fati, a suburb of Canton, Fatshan, a city about twenty miles southwest of Canton. The total number of telephone lines in Canton and the suburban centers runs up to about 3,000, mostly automatic. It is hoped that by the end of the current year the whole telephone system will be turned completely automatic.

Recently the Canton Municipal Government rewarded a contract to the China Electric Company for the construction of a distant telephone system between Hongkong and Canton. Much work has been done already, and first trial direct telephonic communication betweeen the two cities was effected last month. This piece of public work costs the City of Canton over one million dollars Chinese currency, it is reported.

The City of Canton can be arbitrarily divided into two important sections, namely, Canton Proper and Honan, the populated region opposite Canton Proper, on the southern bank of the upper reach of the Chukiang River. Roughly speaking, one-third of Canton's population lives in Honan, and many of them have to cross the river to Canton to conduct their business or attend to work every day. One popular means of transport across the river is "sampans" or small row-boats. Thousands of them are engaged in carrying persons between Canton and Honan, and are sporadically supplemented by numerous motor-boats, mostly private owned. That this mode of travel is not at all satisfactory is self-evident, to say nothing of delay and inconveniences it has caused to the commuters. In case of bad weather, storms, or typhoons, the whole communication system will be disrupted, while even under good weather conditions, boats are not available at night. This state of affairs proves to be quite a nuisance to the people of Honan. With a view to improve communication and to facilitate traffic between Canton and Honan, the Municipal Government of Canton has decided on the construction of a cable suspension bridge over the Chukiang or Pearl River, connecting Honan with Canton. Plans have been submitted by many architects, both Chinese and foreign; and the City Planning Commission of Canton is now considering these plans. Announcement of choice will soon be made and tender received for the construction of the bridge. As no definite declaration has been made by the City Planning Commission, as to specifications of the bridge, for the present it is sufficient to note that this gigantic undertaking is seriously occupying the attention of the Administration of the Canton Municipality.

The Hai-chi Island, to the foreign residents in Canton known as the "Dutch Folly," is situated in mid-stream of the Pearl River, dividing it into two channels, the larger one being on the Honan side and the smaller one the Canton side. The island is not large; so it does not interfere with shipping in any material way. The channel on the Canton side is 172 feet wide, and is, therefore, impassible to steamers. The Canton Municipal Government, with the intention of widening the Bund, which is now over-crowded and is too narrow for the heavy traffic even of the Canton of to-day, plans to fill up the channel on the Canton side and reclaim a long strip of land, thereby connecting Canton proper with Hai-chi Island. When this project is completed, the Bund will be the widest street in Canton—capable of handling the present heavy traffic and whatever increase may come with the rapid development of the city.

(Continued on page 255).

Modern Japanese Hydro-Electric Power Plant

Sho-Gawa Power Plant No. 2: 46,000 K.W.

By T. Kuga, Water Power Engineer, Showa Electric Power Co., Ltd.

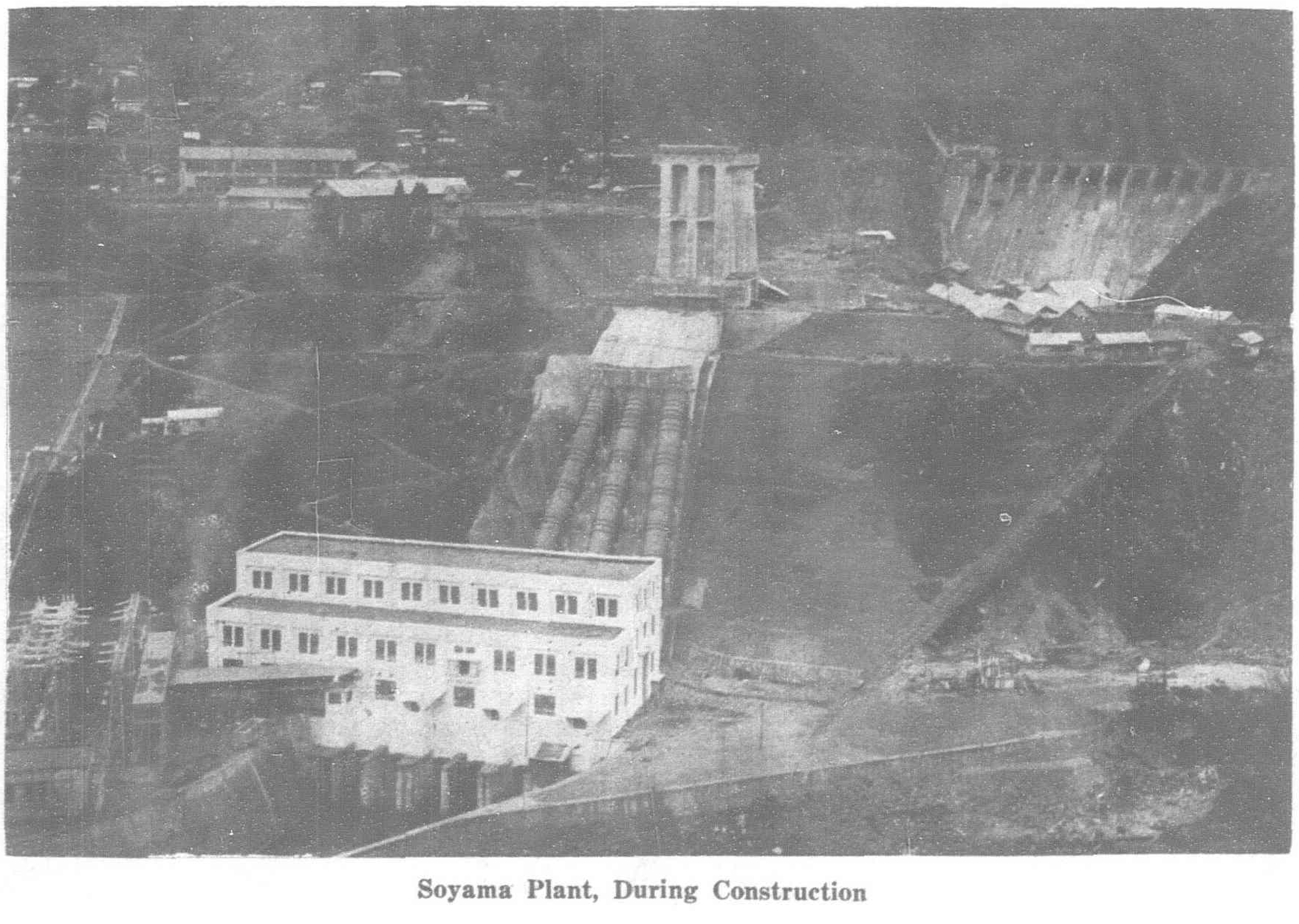
Having abundant water power resources and being less favored with coal supply it is natural that the Japanese should give his best attention to the development of hydraulic power. The progress in this direction has been very rapid and has kept pace well with the rest of her industrial advancement that is characterized as "wonders of the Modern Day." In year of 1906 there were only 38.622 K.W. developed water power and the latest census of 1927 gives the corresponding figures of 2,111,087 K.W. As an example of dam type power development, the Soyama Plant of the Showa Electric Power Co., is one of the latest and best installations in Japan.

It is the first of series of power stations to be developed by the Showa Electric Power Co., in the Hokuriku District, whose aggregate amount will ultimately reach more than 200,000 K.W. The physical features of the Shogawa Power Plant, No. 2 (Soyama Plant) are as follows :

(1) Total storage water quantity = 33,000,000 cu.m.
(2) ,, available ,, ,, = 8,350,000 ,,
(3) Drainage area = 929.4 sq. kilometers
(4) Pondage area = 1.4 sq. kilometers
(5) Back water effect = 10.2 kilometers
(6) Available water quantity = 82.5 cu. m/sec.
(7) Effective head = 66.8 m.
(8) Max. horse power = 73.538 H.P.
(9) ,, output = 45,594 K.W.

The Shogawa (Sho River) has its source in the high plateau of Hida District which separates the waters to northward and southward flows. Winding northward between high steep mountains, collecting numerous small streams on its course, passing and irrigating the Toyama Plant, the river empties into the Japan Sea near the city of Takaoka. It is about 118 kilometers long. The sharp gradients and the steep bluffs on both sides of the river offer sites most favorable for dam type development.

Due to much rain fall throughout the year in these localities, the flow of the Shogawa is subjected to a less change compared with other rivers of Japan. Its average quantity is rated as 60 cu m/sec; the minimum, 30 cu. m/sec : and the maximum flood quantity ever recorded is 3,200 cu. m/sec :



Soyama Plant, During Construction

Location

The dam and power house as shown in the accompanying photographs are located in Taira-mura, Higashi-Tonami-gun (country). Toyama Prefecture. Although it is not very far from sea coast, about 40 kilometers, the place is in the midst of mountain regions, well-nigh inaccessible and offered little opportunity for development in early days. Its very inaccessibility offered for many centuries a secluded and peaceful abode to the small group of refugees and their descendants of the Taira Clan who was defeated in the battle of Kurikara Summit by the rival clan of Minamoto, during the great civil war of Genpei Era (about 1175). They lived a life of mountaineers, seeking out the bare existence by hunting, fishing, and what not with hardly any ground for agricultural cultivation. The village owes its name to them.

Before the advent of the present enterprise, the communication with the outside world was only by means of primitive foot path over the Sugio Summit of 1,100 meters high and during four months of winter season, the heavy snow falls and the consequent danger of snow slides made the inhabitants besieged prisoners.

The first important problem to consider and to solve was the question of transportation facilities and a considerable amount of time and money was spent by the company. It was no easy problem to solve over-night. A transportation road of over 18 miles or 29.5 kilometers had to be constructed over the summit of over 700 meters high mountain ; secondly an aerial cable way of approximately 1/5 tons or 200 k.g. capacity, 5.3 miles or 8.5 kilometers long was built starting near the vicinity of Johnana Railway Station of the Imperial Japanese Government Railway over the Sugio Summit of 1,100 meters high, direct to the dam site, to carry cement and other materials of lesser weight and bulk ; to transport the heavy electrical and hydraulic apparatus as well as the mechanical parts for the dam, intake, and other places, an unique method was adopted, that is, to load heavy pieces not exceeding 15 tons a piece on boats at a place called Komaki and then they are to be pulled upstream either by gasoline winches or men-power according to the weights of loads for a distance of 10.7 kilometers against the swift current, rapids and turns. When the roughness of the river bed and the forbidding steepness of both banks are considered, the difficulties of the haulage are readily appreciated, yet this method proved to be the practical solution under the circumstance.

At the site of the dam the river makes a complete horse shoe turn and it was decided to construct two dams,—the main and secondary ; the former being located at the apex of the horse shoe and the latter being located few hundred feet up-stream from the main dam for the purpose of re-enforcing the left embankment against the pressure of the impounding water and also to keep the embankment level higher than that of the reservoir water. The mountain's on both sides of the main dam form natural abutments. Core borings drilled at various places all indicated the foundation to be of hard granite whose compressive tests gave results as high as 1,000-2,000 kg./sq. cm. proving that they are of sufficient strength. The right bank of the river to a height well above the reservoir level is of the same character while for the left bank it was necessary to remove loose material some six meters endwise until a satisfactory formation was reached. The foundation for "Jo" or secondary dam was found to be not quite so favorable and a corresponding measure of safety was devised.

Main Dam

The dam is of solid concrete masonry construction, designed as a straight gravity type. Its dimensions are as follows,—the total length at the top is 128 meters, the width at base, 64 meters ; the width at top four meters ; the height above the river bed rock is 73.2 meters. To collect seepage water under the dam and to prevent up-lifting and possibly sliding, a longitudinal drain or cut off trench of one meters deep was installed few motors downstream from the face of the dam and the same method was applied on the apron end. Nearly 120 grout holes of 3-in. or 75 m/m diameter, 20-30 meters deep were drilled in the foundation and grouted under pressure. To reduce seepage through the vertical construction joints, copper sheets of three m.m. thick were installed throughout the dam. Two sluiceways, each having the dimensions of five meters wide and about seven meters high are provided with the dam, at place a trifle above the river bed, to handle any surplus water during flood time that the diversion tunnel is unable to discharge. Four grout pipes of one meter diameter are connected to each sluice way at an angle of 30 degrees from the down stream face of the dam.

From the crest of the dam eleven gate piers, spaced 9.4 meters on centers, and 10 meters high are installed to support the shafts of twelve tainter gates of 6.5 m. × 7.6 m. and also a platform of four meters wide and 112 meters long, upon which the controlling mechanisms of the tainter gates are to be mounted and operated either manually or electrically by 15 H.P. motors. These mechanisms are to be entirely covered on account of heavy snow falls. Besides there are two Stony gates, 2.5 m. × 7.6 m. located right underneath the two extreme right hand taintor gates, to flush sand and gravel whenever necessary, below the intake elevation. The total amount of concrete required for the main dam is estimated to be 150,000 cu.m.

Secondary Dam

The dam is a gravity non-overflow type. It is 25 meters high from the foundation level and 180 meters long measured at the top and is calculated to require about 36.000 cu. m. of concrete. Test borings indicated that the foundation formation is of somewhat loose and soft character and it was decided to make the cut off trench deeper until the solid rock bed is reached, the deepest place being 30 meters. At the latter place, two strong abutments are constructed and the space between them are built of re-enforced concrete, having been designed as reinforced beam section. Series of grout holes were made on the founation and grouted under pressure. Wherever possible, a proportionate thickness of concrete coating and re-enforced concrete were applied to insure safeness and prevent possible damage in future.

Intake

The intake is located on the right side of the river about 43 meters upstream from the main dam. It has four steel gates of 4.8 m. × 4.8 m. with manual and electrical operating mechanism. A special protection against snow slide from the back hills is provided. In front of the gates are placed screens of 2-in. or 5 cm. apart mesh to protect against accumulating leaves and other debris and further ahead of these screens are installed booms upon which another screens are suspended against logs, floating ice and snow drifts.

From the intake, a pressure tunnel of about 500 meters long starts and connects to a surge tank located immediately back of the power house, about 50 meters high above the turbine center. This circular tunnel has its inside diameter of 5.7 meters and the thickness of the lining varies between 0.5—0.6 meters, strongly reinforced with angle irons and bars, using over 1,200 tons or 1,000-000 kgm. Special attention has been given to make good joints between the outside lining of the tunnel and ground by proper and careful grouting.

Surge Tank

The surge tank is located at the elevation of 228 m. above sea level and is of reinforced concrete construction. It is designed to meet all cases of water surges caused by sudden change of loads due to short circuits. Its dimensions are 32 meters in height 16 meters in diameter, and the thickness varies according to height, 0.5 and 2.5 meters being the respective thickness at the top and bottom. Altogether over 1,000 tons of reinforcement bars are used. In the tank, three openings for penstocks are provided, and also three flap gates of 12 tons each, whose diameter is 14-ft. 2-in. or 4.36 m. with by-pass valves are installed for the control of water to the penstocks.

Penstocks

Three independent pipe lines from the surge tank connects to the turbines below in the power house. Its developed length is 103 meters : 4.115 meters in diameters, and its thickness varies from 12.7-28.6 m.m. They are of mild rivetted steel plates with one expansion joint in each main pipe line, located at about 1/3 distance from the top. A provision is being made to measure by Allen method, the water quantity for the efficiency of the turbines. For air vent three stand pipes of 3 ft. or 0.915 m. dia. and of the same height as the surge tank are installed adjacent to the tank. From the base of each penstock a 2-ft. or 0.61 m. dia. pipe line is tapped off at an angle of 45° and connected to a 3-ft. main pipe which in turn is connected to each exciter turbine by 2-ft. dia. pipe line.

Power House

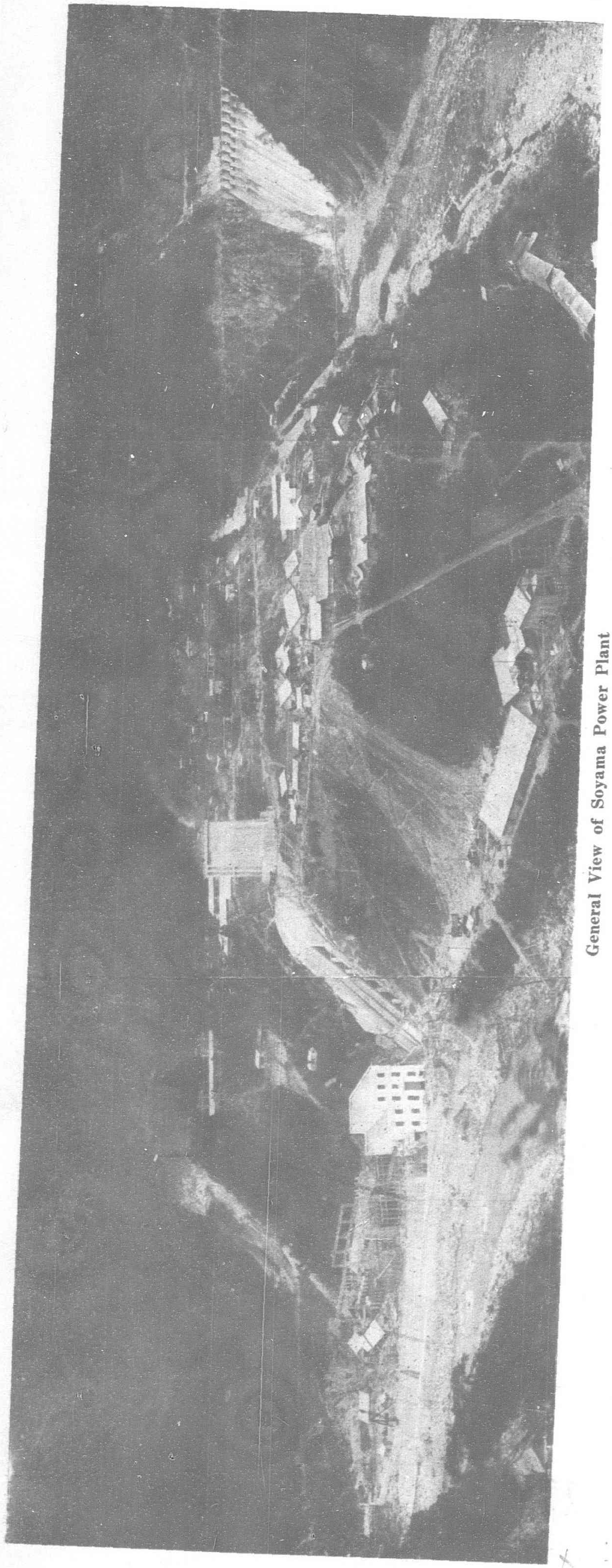
The Power house is a part two story structure of reinforced concrete and is calculated to sustain the heavy weight of hydraulic and electric apparatus. The roof is made strong enough to carry the maximum weight of heavy snow that reaches more than 10-ft. in depth and instead of using the regular truss formation, the reinforced concrete beams are substituted, to reduce the height of the structure. It has the floor area of about 1,300 sq. meters : is 22 meters wide and 58.6 meters long ; 18.5 meters high above ground ; and the exacavation depth of 15.5 meters was done to meet the requirement of the Moody's cone draft tube installation. Altogether, 1,360 cu. m. of concrete for the building and foundation, and 480 tons of reinforcement bars were used. Heavy supporting walls or "concrete barrels" were built right on the turbine casing to the height of the generator floor, to sustain without vibration the enormous combined weight of a generator, turbine runner, and water thrust, and also heavy stresses due to short circuits.

Tailrace

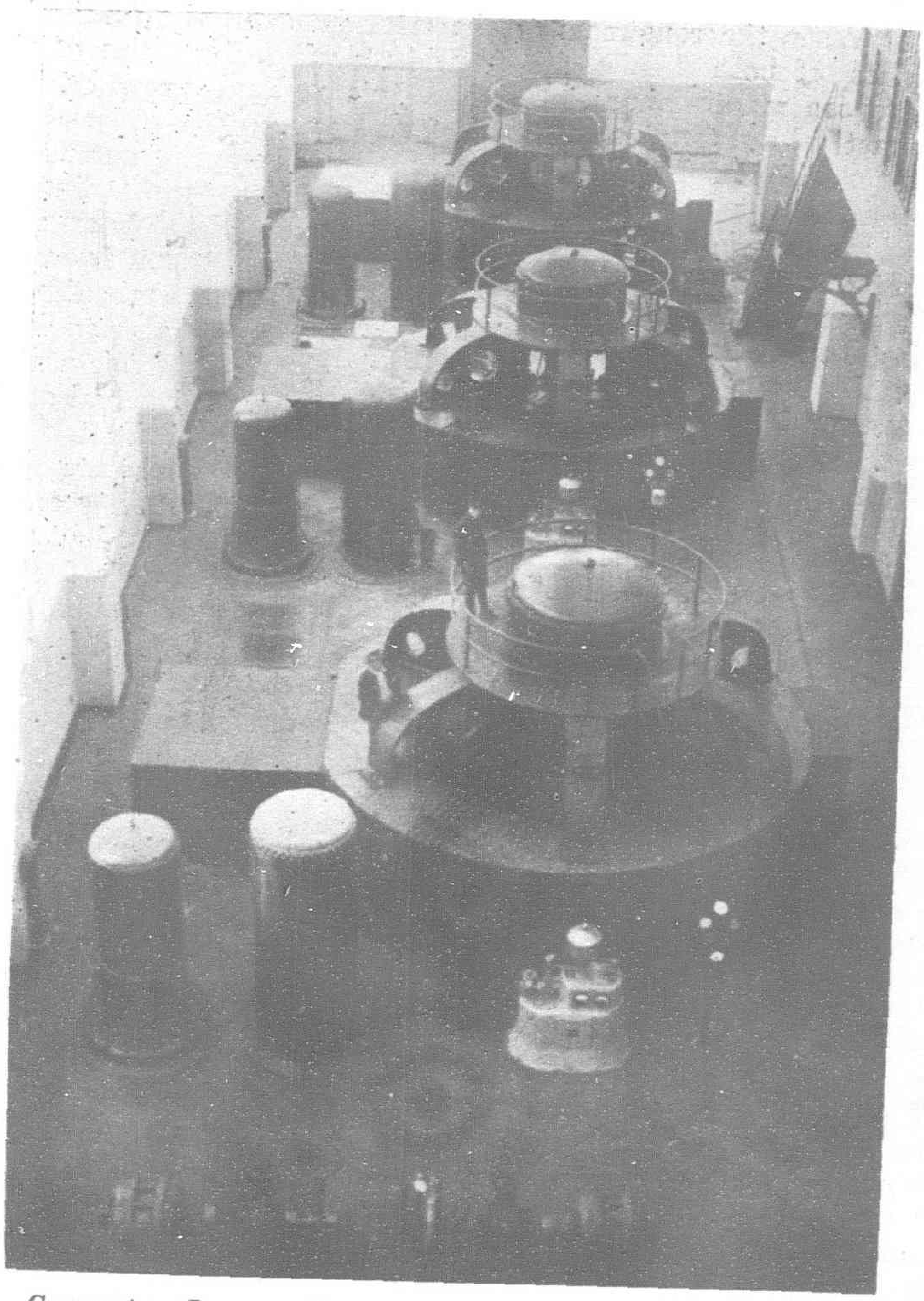
The tail race is an open canal, of trapexoidal cross section having the concreted bottom and the sides of kenchi masonry construction. It is 153.8 meter long, 10 m. deep, 30.3 m. wide at the top and 16 m. at the bottom. Near the power house structure where the tail race begins it is 46 meters wide and tapers to the above mentioned width within 12 meters distance. The grade is 1 : 1,000.

Construction Equipment

Before the construction work proper began, it was necessary to built a diversion tunnel and this problem was happily solved by locating such tunnel at the place where the horse shoe turn begins and ends. This opportune selection enabled the construction to

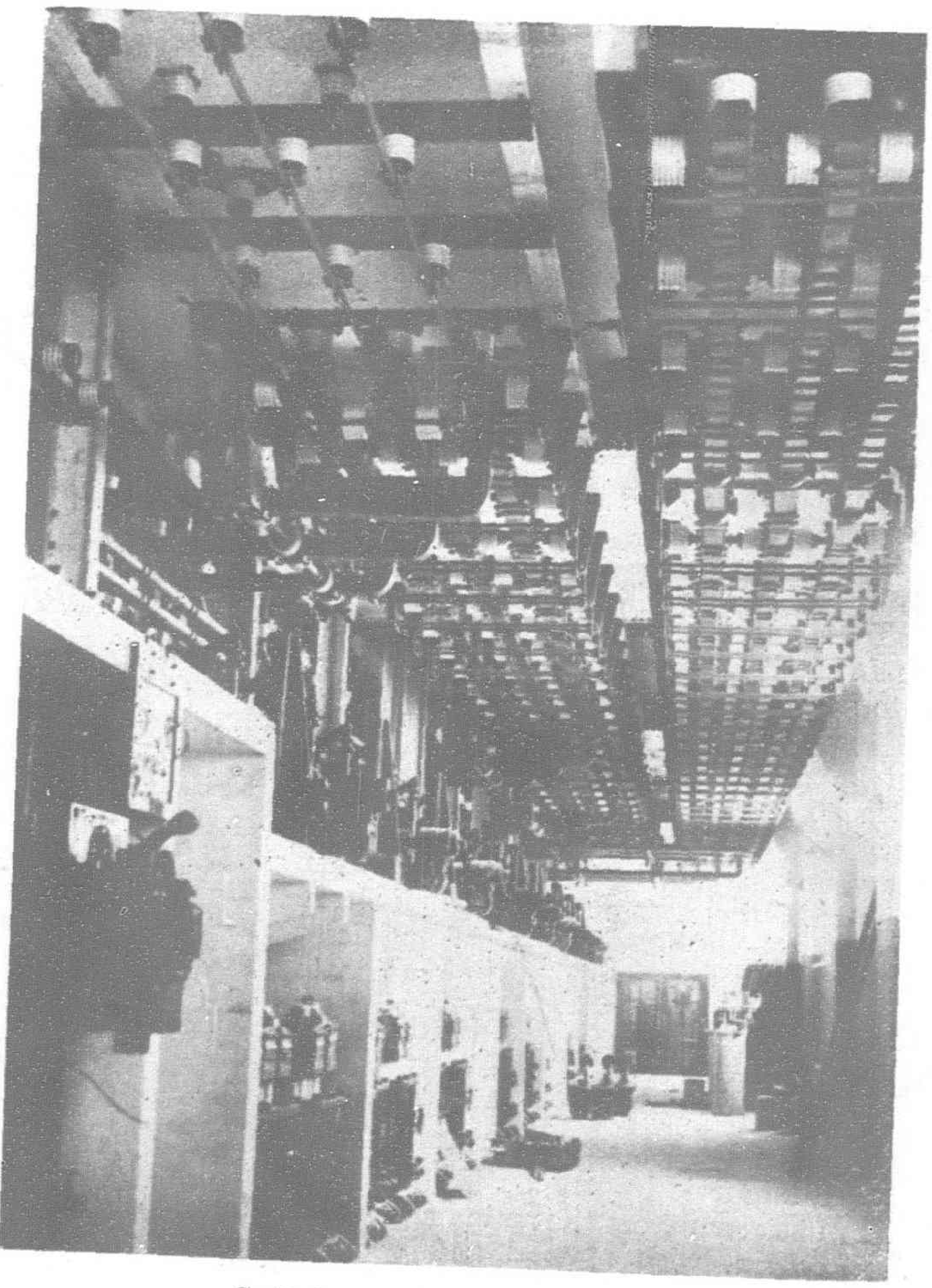


General View of Soyama Power Plant



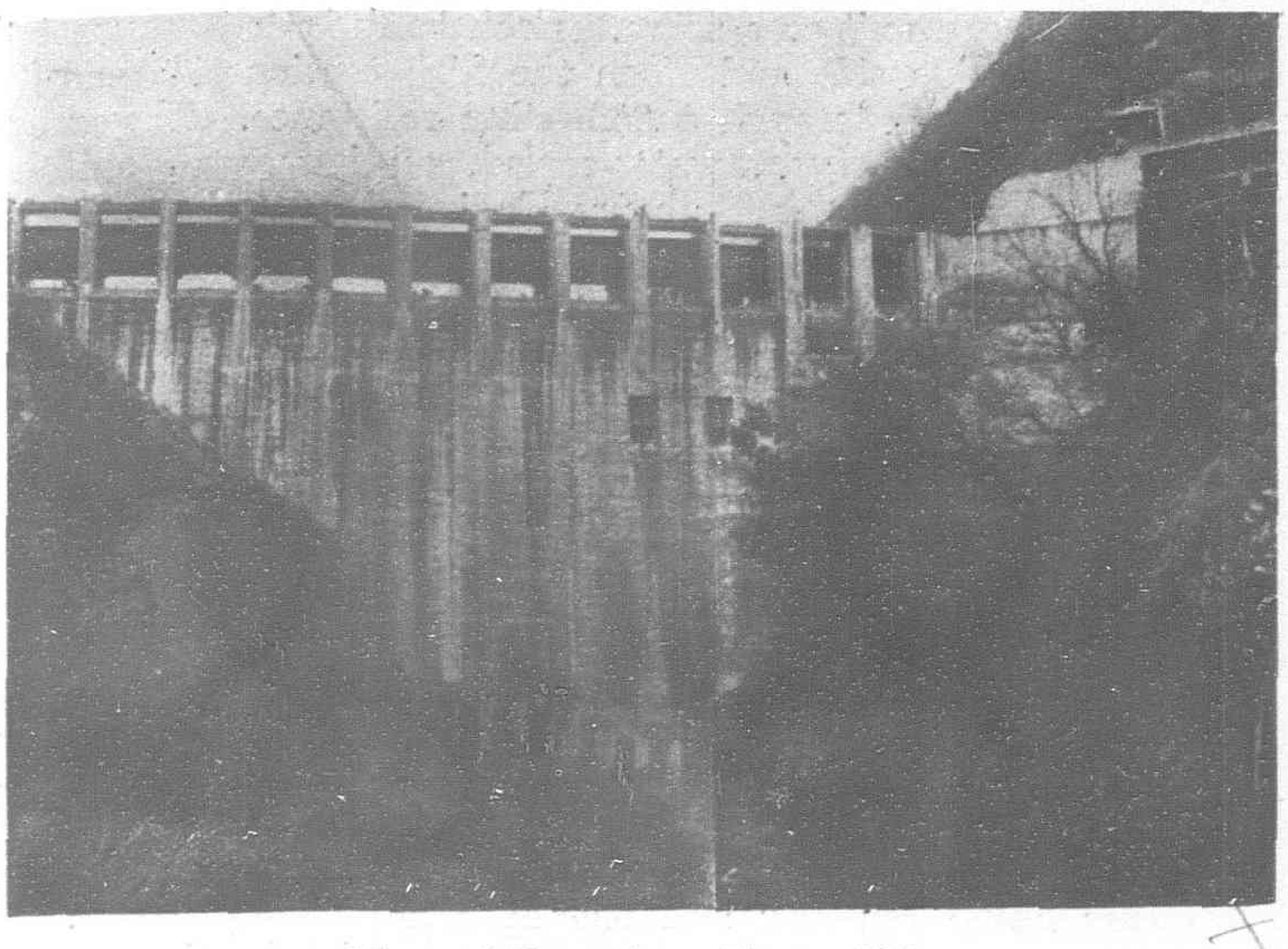
Generator Room: Three 20,000 K.V.A. Vertical General Electric Generators Driven by I.P. Morris Water Turbines

2



Switchgear Bus Compartment

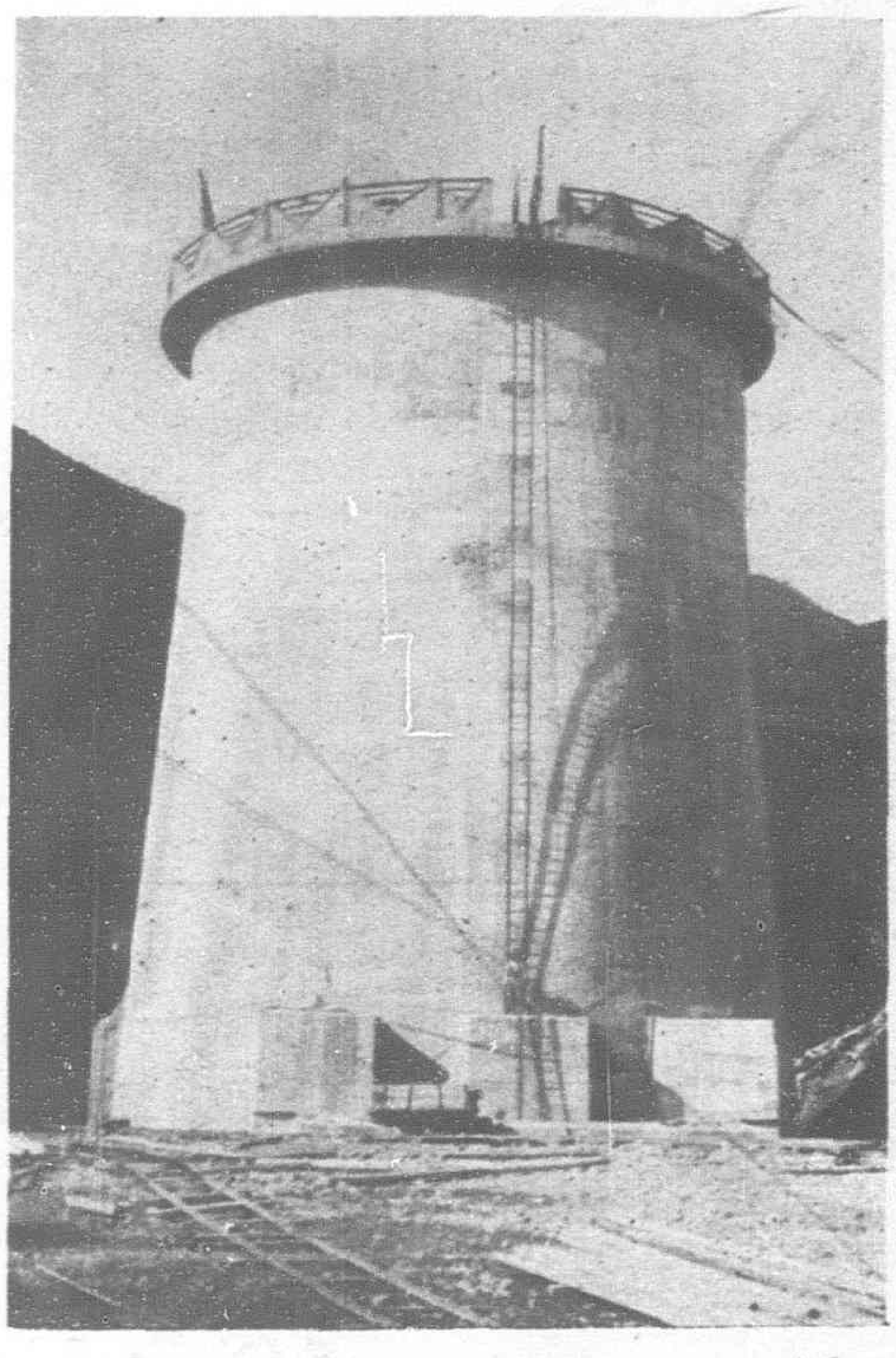
3



View of Dam from Upper Side

proceed almost independent of small floods that frequent these localities throughout the year. It is 5.5 meters high, five meters wide, 116.7 meters long, grade of 1:80 and its discharge capacity is 250 per sec.

The topography of the place favoured the location of the concrete mixing plant as was in the case of the diversion tunnel. A high and commanding promontory located between the two dams is an ideal place, for from this height, a greater part of concrete for the dams can be poured by simple gravity method and the remainder is to be hauled by gasoline engines to the work trestle, from where concretes are either emptied or hoisted to proper height for pouring. Fifteen or more cable ways radiate from the mixing plant to all directions to hual up cement, sand, gravel, crushed stones, and so forth. Six concrete mixers are installed, four of 1 cu. yd. capacity and two of 10 cu. ft. capacity. The ratios of concrete mixture are 1:3:6 for plums 1:2:4 for special parts and the bulging effect of sand is carefully considered. Careful inspection is given to the qualities of cement, sand and gravel used and their samples as well as those of concrete are taken from time to time, examined, and tested in the Laboratory provided with special measuring machines. None but those approved are used. The workability of concrete is limited between two and six cm. by slump test. The test of 30 cm. dia. cylindrical piece indicates the compressive strength of 150 kg/sq. cm. for 1:2:4: mixture and 100 kg/sq. m. for 1:3:6: mixture at one month's ageing and for a cubic test of the Dam piece (1:3:6:), 200 kg/sq. cm. is the result for six month's ageing.



Surge Tank

Whenever a fresh concrete is added to the previously poured concrete, the face of the dried concrete is roughened with pneumatic cutter and a coating of fresh rich mortar is applied to insure fast and good joints. During the winter months of cold weather when the concrete is liable to freeze, the electric heating device was used to a considerable extent. Water for mixing was warmed up; sand and gravel were also treated to heating to be free from frozen ice and snow. When the concrete was to be kept from freezing during night or some intervals, electric heaters and tents were brought into play and kept the temperature under the cover within 2°C. to 5°C. when the ambient temperature registered as low as 10°C.

Electric Equipment

The output of the Showa Power Station is 60,000 K.V.A. generated at 6,600 V. and then the power is stepped up to 154,000 V. by means of two banks of transformers of 13,400 K.V.A. each for power transmission to Osaka.

Turbine

Three units of 27,000 H.P. vertical single runner, rivetted steel plate casing, Francis type turbine made by I.P. Morris Co., of U.S.A. are prime movers. The runner is of cast steel in one piece weighing about 11.5 tons or 10,000 kgms; the main guide bearing is of lignum vitae; the draft tube is of the Moody spreading type made of reinforced concrete, lined with steel plates in sections; the top of hydrocone is capped with a steel plate; and all rivets are either welded or caulked to prevent possible leakage and also to lessen friction. A butterfly valve of 10-ft.—6-in. or 3.2. meters with a by-path valve controls the passage of water and is to be operated either by hand or by oil pressure and in case of oil losing its pressure on the governor's system, the valve can be operated by oil pressure from a special tank provided just for such occasion. The Morris Pelton Actuator type of governor belt driven from the main shaft is used and is located on the generator floor.

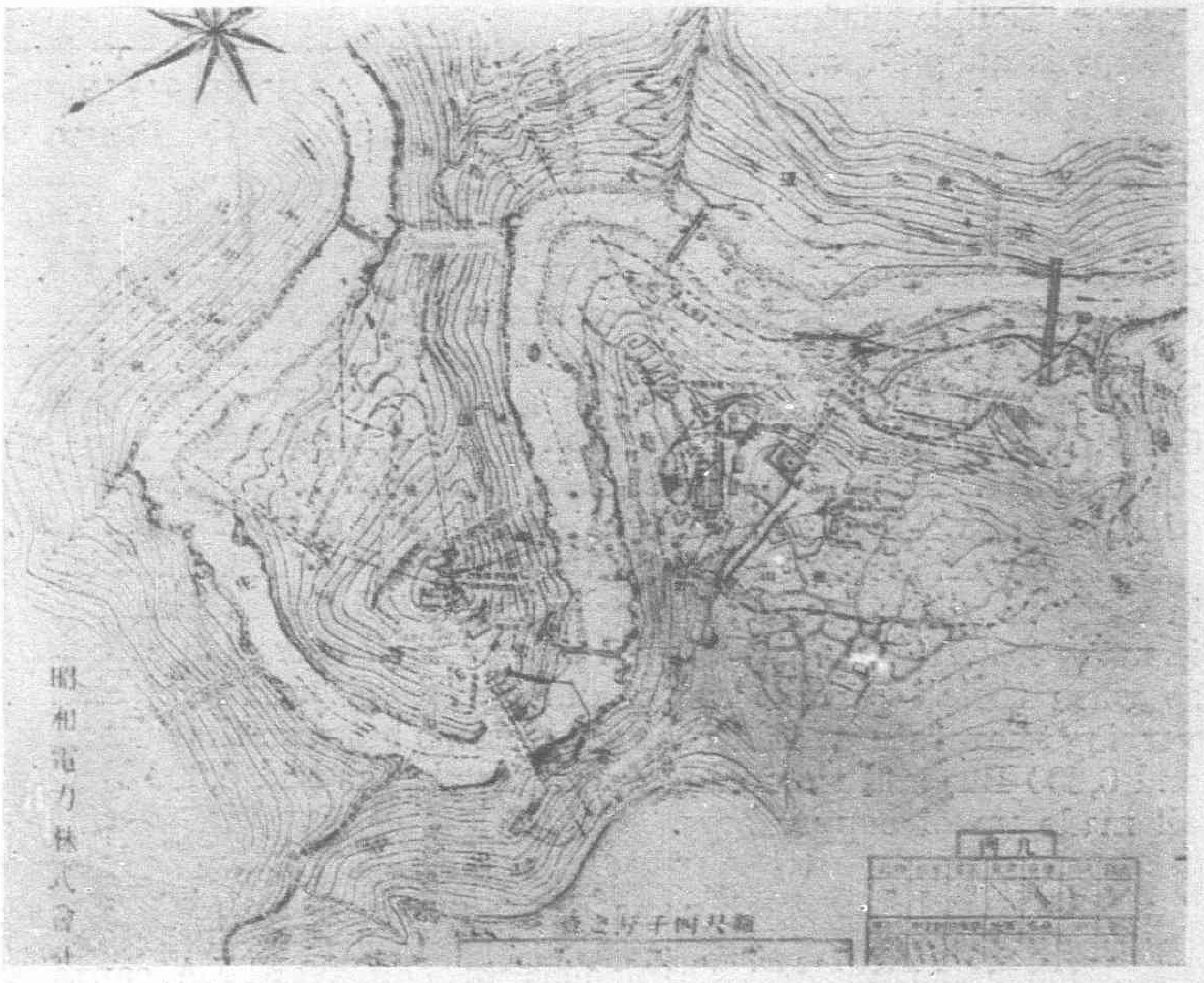
The turbine is guaranteed to give 89 per cent. efficiency for full load at the normal head and the speed variations are 21 per cent. for when full load is suddenly thrown off and 26 per cent. when suddenly on.

There are two rotary pumps for pressure regulators, the capacity of one pump being sufficient for the operation of three governors and they are so arranged that they can be separately driven electrically by two motors or by one horizontal water turbine which is used as a spare.

The Dengyosha Prime Mover Works Ltd., of Tokyo furnished two 900 H.P. horizontal, single runner, single discharge, Francis type turbine for two exciters. They are to be directly connected to each exciter with solid forged flange coupling.

Generator

The three main generators are rated A.T.B. 36-20,000 K.V.A. 16,000 K.W. 200 H.P.M. 6,600 V. 60 cy. P.F. 0.8 clockwise rotation, made by the General Elect. Co., of U.S.A. The machine is capable of operating at 105 per cent. terminal volts at full load continuously and it has also a sufficient capacity to charge the Osaka transmission line of 154,000 V. The neutral of each machine is grounded through an oil switch. The G.E. spring type bearing is used for its thrust bearing, and is designed to sustain the combined weights of the rotor, shaft, turbine, and water thrust of 130,000 lbs. totalizing to about 330,000 lbs. or 150,000



General Plan of Soyama Development

kgms. Usual complete tests were made on one machine while only balance tests were applied to the remaining two rotors, before the shipment. The steel plate frame forms an integral part of the bentlating hood, thus saving a considerable floor space.

Because of the limitation of the transportation facilities, the generators came all disassembled—the armature frames came in three sections and they were put together and the assembling of core punchings, the placing of coils into slots and connecting them into proper circuits; the shrinking of the shaft into the hub, the assembling of field laminations, the mounting of the field poles and other works were all executed at the plant by the company's staff.

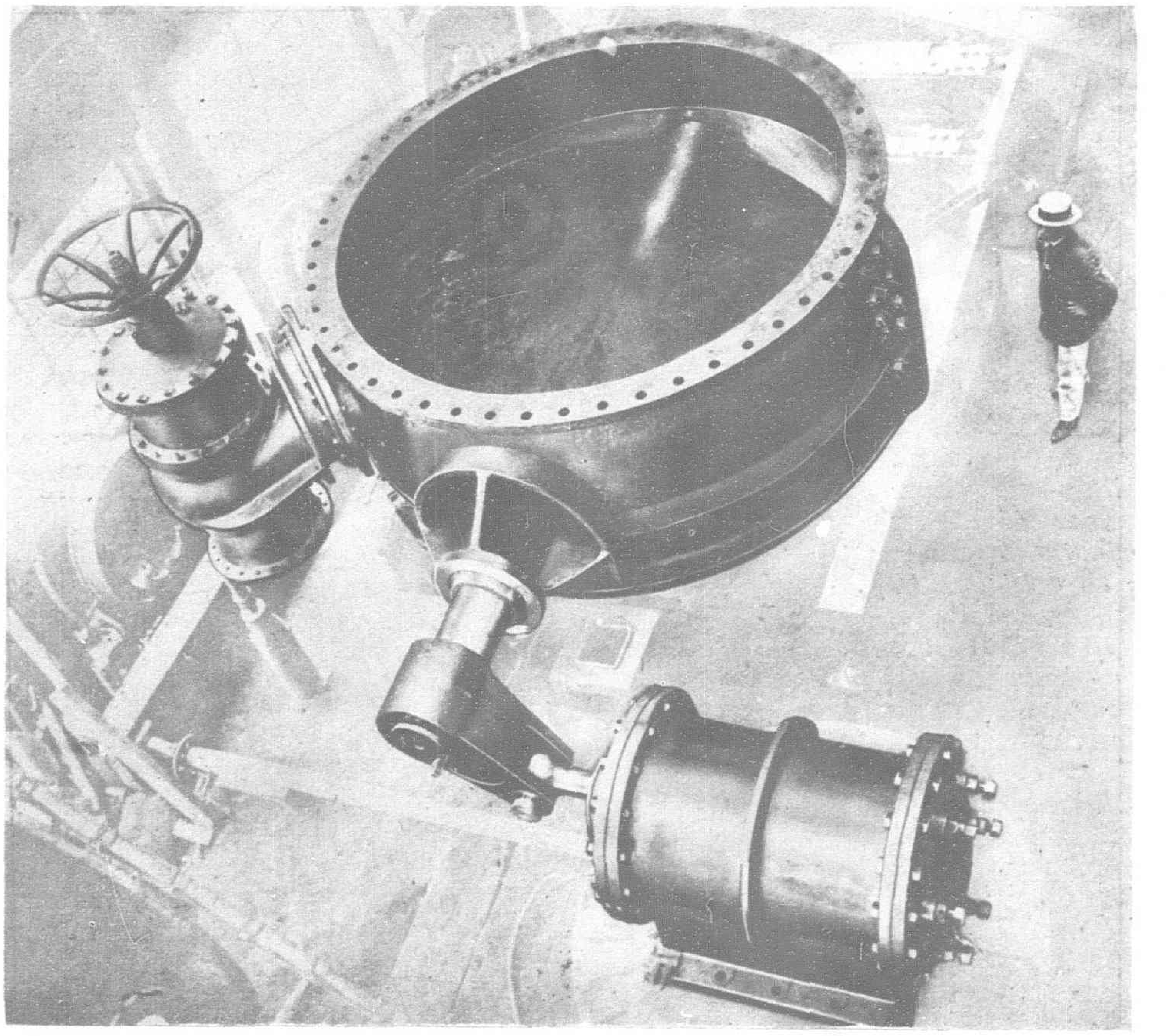
Exciter

Two-500 K.W. exciters of the Shibaura Engineering Works are directly connected to the Dengyo-sha's horizontal turbines. It is intended to use one machine as a spare because of the fact that one exciter has a sufficient capacity to supply three generator field currents.

The rating is M.P. 6-500-900 R.P.M. 250 V. shunt wound with commutating poles, with compensating winding. Two voltage regulators of the Tirrell type made by the Shibaura Engineering Works are installed to regulate the voltage of the generators through the usual means of controlling the exciter voltage.

6,600 V. Bus and Oil Switch

Due to heavy current capacity and consequent troublesome question of local heating by eddy current, a new departure on 6,600 V. Bus system is tried. Instead of being installed within ordinary bus bar compartment of reinforced concrete, the main bus bars are suspended edgewise from I beams, rigidly clamped on both sides by porcelain insulators which also serve as spacers. All bus bars and taps are completely insulated with micarta boards. Double bus bar system is adopted and consists of six layers of copper bars 4-in. × $\frac{1}{4}$-in or 100 m/m × 6.3 m/m. The generators are connected to the bus through the usual method of disconnecting switches and oil switch of special design. No. 1 and No. 111 generators are so arranged that they can be connected to either of Buses or directly to No. 1 and No. 2 main transformer banks respectively, while No. 2 generator has connection to 6,600 V. Bus only. The oil switch has the rupturing capacity of 1,000,000 K.V.A. and before the acceptance of its design, a series of tests in reference to local heating by eddy current was made.



Main Gate Valve of I. P. Morris Turbine for the Showa Hydro Electric Power Plant, made by the Dongyosha Prime Mover Works, Ltd.

Another innovation is that cappoer bars are substituted in place of power cables; the paper insulated cables have shown in many instances defects after a year or so of operation especially so when their terminals are of different levels and subjected to varying temperatures; thus the connections between the generators and 6,600 Bus and the main transformer banks and 6,600 Bus are all made up of copper bars.

Transformer

Each main transformer bank consists of 40,200 K.V.A. capacity, consisting of three single phase 13,400 K.V.A. units. Two banks are installed with one unit as a spare. Each bank is delta connected on the low tension side and Y on the high tension side and its neutral is grounded through a 600—ohm resistance. The transformers are of core type, water-cooled, oil immersed, outdoor type, manufactured by the Shibaura Engineering Works of Tokyo and have the following rating, single phase, Type CWR form HCHCO 60 cycle 13,400 K.V.A. 6,600 V. 95,000/92,000/89,000 164,400/159,200/154,000 Y.

The coils and cores arrived separately and they were assembled, dried, and immersed in oil at the field. Again a new method of drying them under vacuum was tried and proved not only successful but desirable from many points of view, when working at the place where the facilities are none too good.

154,000 V.

The high tension bus structure is rather simple and needs hardly any comments. Due to excessive heavy falls, all operations of oil switches and disconnecting switches are performed from underground and for this purpose an underground passage connects the power house building and the operating compartment. A special heating device is furnished in the mechanism chamber of high tension oil switches to keep the mechanism from freezing. The tractor type of disconnecting switches are used. Two sets of oxide film arresters complete the installation.

Switchboard

The main switch boards consists of seven panel bench-board type, three for generators, two for transformers, one for exciters, and one for feeders and local circuit. Beside these there are two voltage regulator panels and 11 panels for the station service and local feeder circuits. All panels are of black enamelled marble and the meters of delicate precisim, and all known latest type devices against overload, short circuit, unbalancing, grounds, and so forth are utilized and it is hoped that they will equal demand of any emergency case. The tainter gates and stony gates of the main dam and also those of the intake are not handled from this switchboard. The switchboard and switching apparatus are supplied by the Shibaura Engineering Works of Tokyo.

The Hokuriku Transmission line of 154,000 V. that will carry the generated energy to Osaka is about 186.5 miles or 300.26 kilo-m. between Sasazu and Osaka.

When the total amount of 320,000 cu.m. of concrete will have been mixed and poured, 4,500 tons or 3,800,000 kgms. of reinforcement steel angles and bars are imbedded, 2,000 tons of gates and mechanisms and penstocks in their respective places, 3,600 tons of hydraulic and electrical apparatus properly installed, and 33,000,000 cu.m. of water successfully impounded in a reservoir, then the water of the Sho River that had remained unharnessed for many centuries and run ceaselessly on its wild and turbulent course will be brought under the control of man and its mighty potential power will turn the giant industrial wheel in a far distant metropolis, giving work, homes and comforts to a thousand upon thousand of people.

Development of Water Tube Boilers in Japan

With Special Reference to the "Takuma" Boiler

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In Japan, adaptation of water tube boilers for marine purpose is largely limited to war-vessels, and, its history dates back to 1897, when, to the first time in our Navy, Bellville boilers were installed in 2,450 ton cruiser *Chiyoda*, replacing her old boilers ; their working pressure was 242 lbs. per sq. inch. This was followed, in October, 1901, by the adaptation in cruiser *Chihaya* (1,240 tons) the Normand boilers with working pressure of 220 lbs., while, during two or three years preceding this, water tube boilers of small tube type were already being used in torpedo crafts.

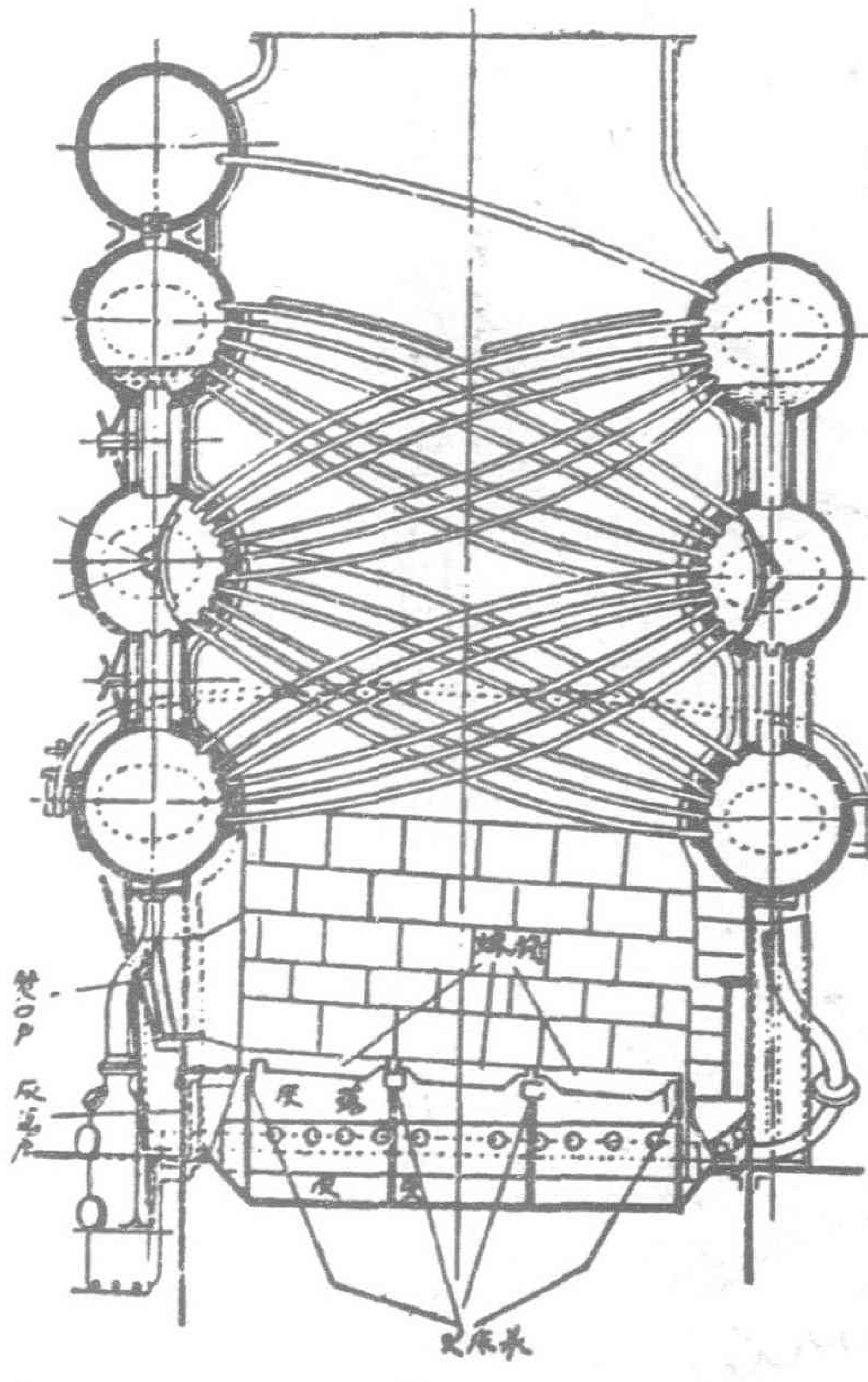


Fig. 1.—"Miyabara" Boiler

Then, came an experimental stage in the development of water tube boilers with a view to finding out the most suitable type for war vessels. In August of the year 1902, old fire tube boilers of the cruiser *Hashidate* werere placed with "Miyabara" boilers, for the first time of the adoption of this type. Successively, in January 1904, Niclause boilers were installed in newly completed despatch vessel *Niitaka* (3,366 tons), and finally, in *Otowa*, a despatch vessel of 3,000 tons, completed in September of the same year, were adapted "A" type Admiralty boilers, the first of the kind designed and built by Japanese Navy. At this time, however, it was already the policy of our Naval Authority that boilers for war vessels should be of water tube type without single exception, and, speaking generally, Bellville boilers were to be used in battle-ships and large cruisers, Niclause, Normand or Admiralty type in high speed light cruisers and despatch vessels, and, Yarrow, Thornycroft or Admiralty boilers in torpedo boat destroyers.

The following Table I shows the names of war-vessels actively engaged in Russo-Japanese War, along with dates of their completion, types and pressures of boilers installed.

TABLE I.

Name of Vessel	Class of Vessel	When Completed	Type of Boiler	Working Pressure lbs. per sq. inch
Shikishima	Battle-Ship	26- 1-1900	Bellville	270
Asahi	,,	31- 7-1900	,,	300
Mikasa	,,	1- 3-1902	,,	300
Yakumo	Cruiser	20- 6-1900	,,	256
Adzuma	,,	28- 7-1900	,,	270
Idzumo	,,	25- 9-1900	,,	270
Iwate	,,	18- 3-1901	,,	270
**Chihaya*	Despatch	9- 9-1901	Normand	220
**Niitaka*	,,	27- 1-1904	Niclause	210
**Otowa*	,,	7- 9-1904	"A" Admiralty	230
**Kagero*	Destroyer	31-10-1899	Thornycroft	220
**Harusame*	,,	26- 6-1903	"A" Admiralty	—

N.B.—Those marked * are the first vessels fitted with water tube boilers specified in this Table.

From the Table I, it is apparent that, until immediately before Russo-Japanese War, every type of water tube boilers seems to have been tried out almost indiscriminately without any established standard. It is evident, however, from what is contained in Table II, that, after the War, with the exception of large number of battle-cruisers in which were installed Yarrow type boilers, Miyabara boilers were used in all of war-vessels larger than cruisers and "A" type Admiralty boilers in destroyers and smaller crafts.

TABLE II.

Name of Vessel	Class of Vessel	When Completed	Type of Boiler	Working Pressure lbs. per sq. inch
Satsuma	Battle-Ship	3-1910	Miyabara	235
Minatsuki	Mine-Sweeper	12-1906	"A" Admiralty	250
Yamashiro	Battle-Ship	3-1917	Miyabara	275
Yamakaze	Destroyer	12-1911	"A" Admiralty	250

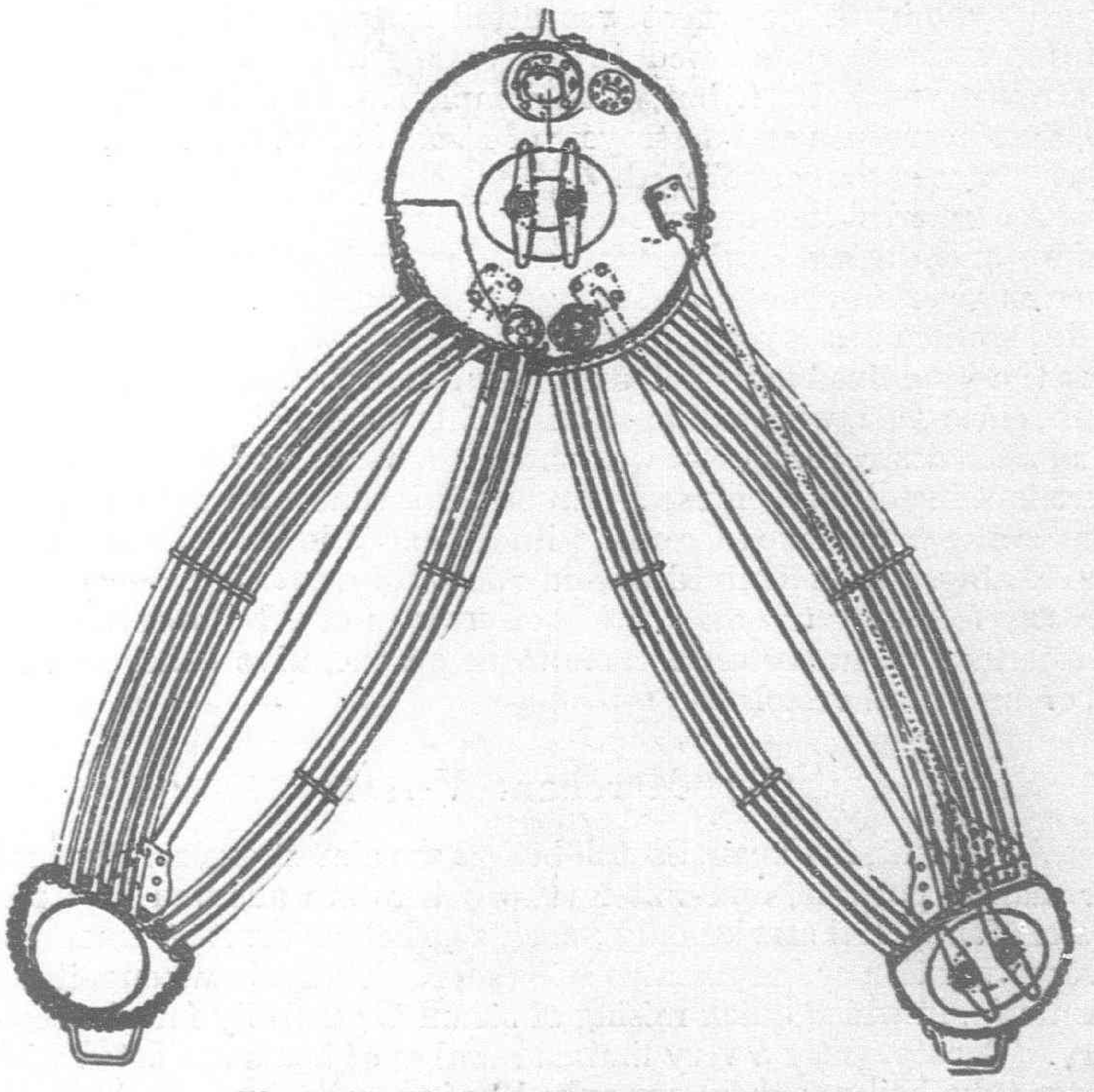


Fig. 3.—"A" Type Admiralty Boiler

Since March 1915 till up-to-date, " B " type Admiralty boilers have been exclusively used for war vessels completed during this period, with the exception for those engaged in special service.

This " B " type Admiralty boiler, while being modified Yarrow's, is in reality an outcome of the knowledge and experience obtained during an experimental period extending over 17 years since 1897, and, toward the end of this period, it was recognized that Yarrow type is the nearest to an ideal boiler adaptable to meet the requirements of Japanese Navy.

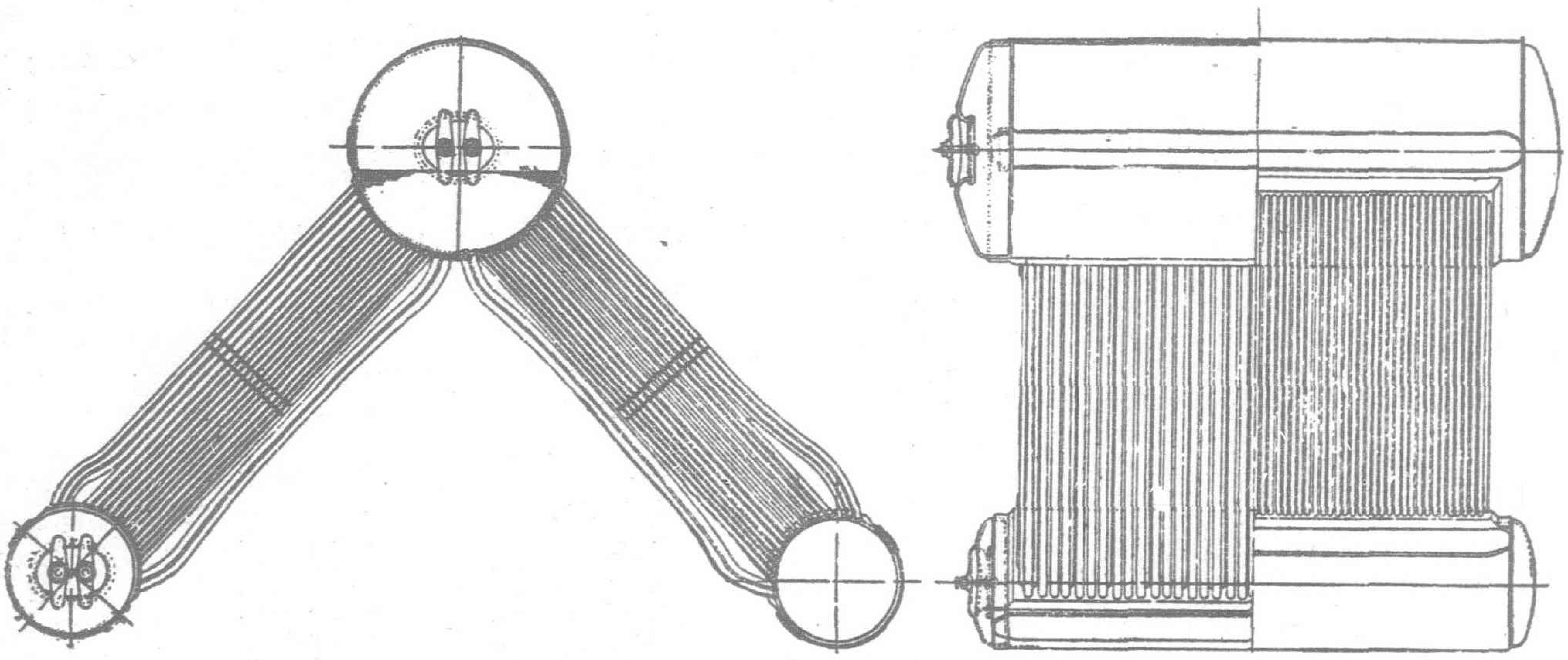


Fig. 4.—"B" Type Admiralty Boiler

Thereupon, besides a few minor improvements, major modification was accomplished by making mud drum to have circular cross section, thus doing away with the flattened tube plate of the original type, in order to ensure more even distribution of stress in the material. " B " type Admiralty boiler is now standard boiler in Japanese Navy.

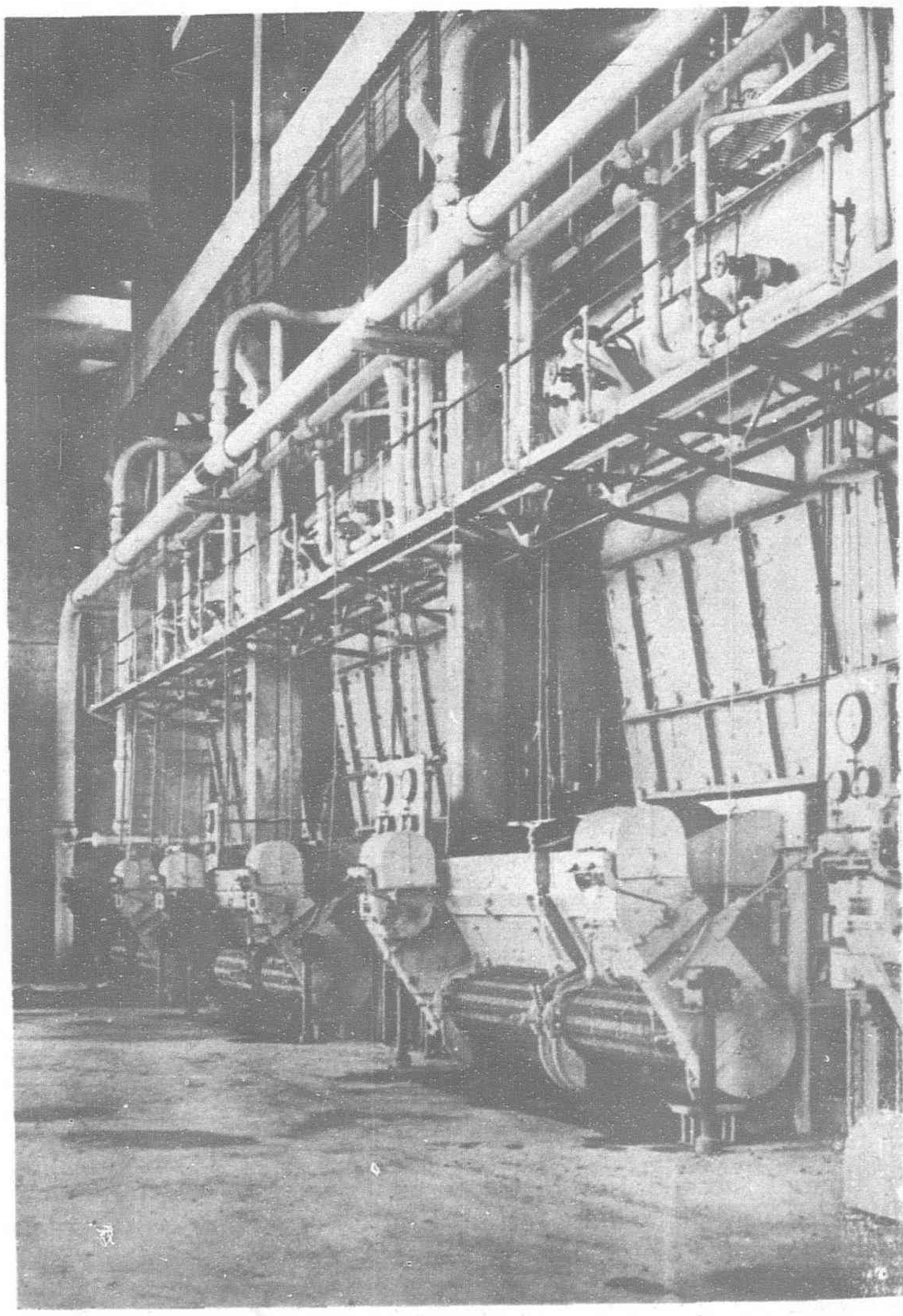
As to the working pressure of boilers, 275 lbs. had been used for battleships and cruisers, and 260 lbs. for war vessels lighter than cruiser, until 1927, when universal adoption of Metric System coming in effect, the working pressure was standardized at 20 kilos. per sq. cm. This standard pressure was applied in the boilers of new 10,000 ton (*Myoko* Class) cruisers and more recently completed first class destroyers of the *Fubuki* type.

Regarding the degree of superheat, 50° F. had been standard for *Miyabara* boilers, while no superheaters were provided for boilers of other types, until November, 1918, when superheater capable of giving 100° F. superheat was fitted in large destroyer *Yekaze*. This practice was followed in all vessels larger than first class destroyers, until 1927, but, with completion, in this year, of new 10,000 ton cruisers and destroyers of *Fubuki* class, the use of superheaters was entirely abolished.

As regards the boiler fuel, coal had been exclusively used before and during Russo-Japanese War, but, after the War was over, mixed firing of coal and heavy oil was adopted. In September of 1911, when destroyer *Umitsuki* was completed, our Navy, for the first time, specified heavy oil as her exclusive fuel. New destroyers built, since then, were equipped with oil burning boilers, and, by the time when destroyer *Yekaze* was completed in 1918, all our destroyers were burning oil as their fuel. Around this time, cruisers and larger vessels also were made to use oil, with the exception of boilers allotted for cruising, in which mixed burning was still prevailing. However, directly following the completion of cruisers of *Myoko* class about two years ago, heavy oil became to be an exclusive boiler fuel for all of our Naval vessels.

(B) Merchant Vessels

At present, in Japan, Scotch boilers are almost exclusively used for marine purpose, and water tube boilers are adopted in a few vessels for special service only ; such as, shallow draft steamers for river navigation or ferry boats plying short distance between railway terminals, in which quick raising of steam is generally found necessary. Consequently a very limited number of boats are fitted with water tube boilers ; there are only 13 of them, counting all vessels over 100 tons. TABLE III gives some particulars of these vessels. It will be seen from this Table that Babcock & Wilcox and Ikeda types are mainly used for ferry steamers, while Thornycroft and Yarrow boilers are adapted in steamers engaged in service on Yangtze River, China.

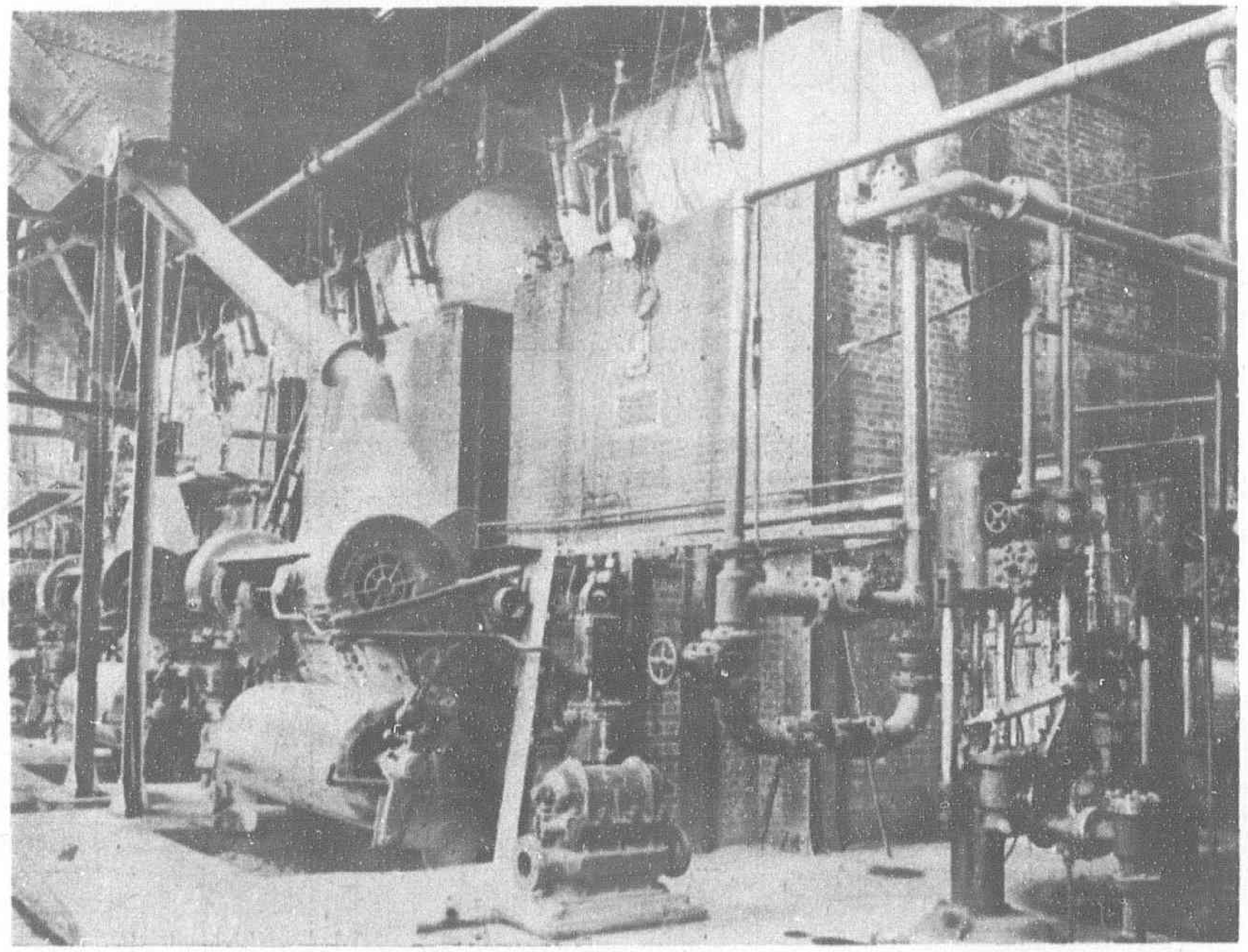


A MODERN HIGH PRESSURE BOILER PLANT IN JAPAN

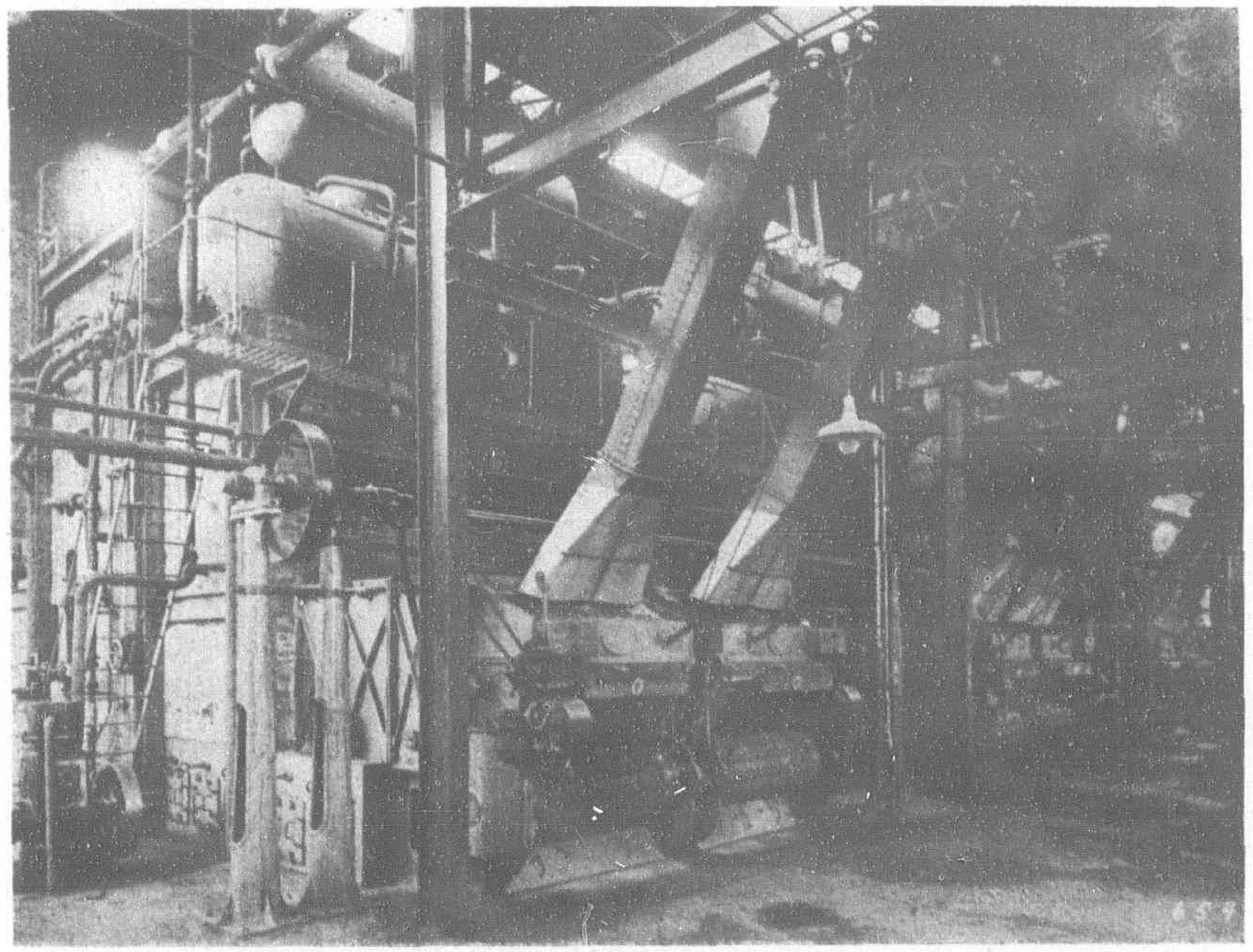
Four Babcock and Wilcox Boilers Installed at the Shibaura Station of the Tokyo Municipal Electric Bureau; 6.156 sq. ft. Heating Surface, with Superheaters of 2,772 sq. ft. of H.S. and Superimposed Economiser of 4,476 sq. ft. working Pressure 275 lbs. per sq. m. and final Steam Temperature of 690° F., also Compartment Stokers of 126 sq. ft. Grate Area.

TYPICAL "TAKUMA" BOILER INSTALLATIONS IN JAPANESE POWER PLANTS

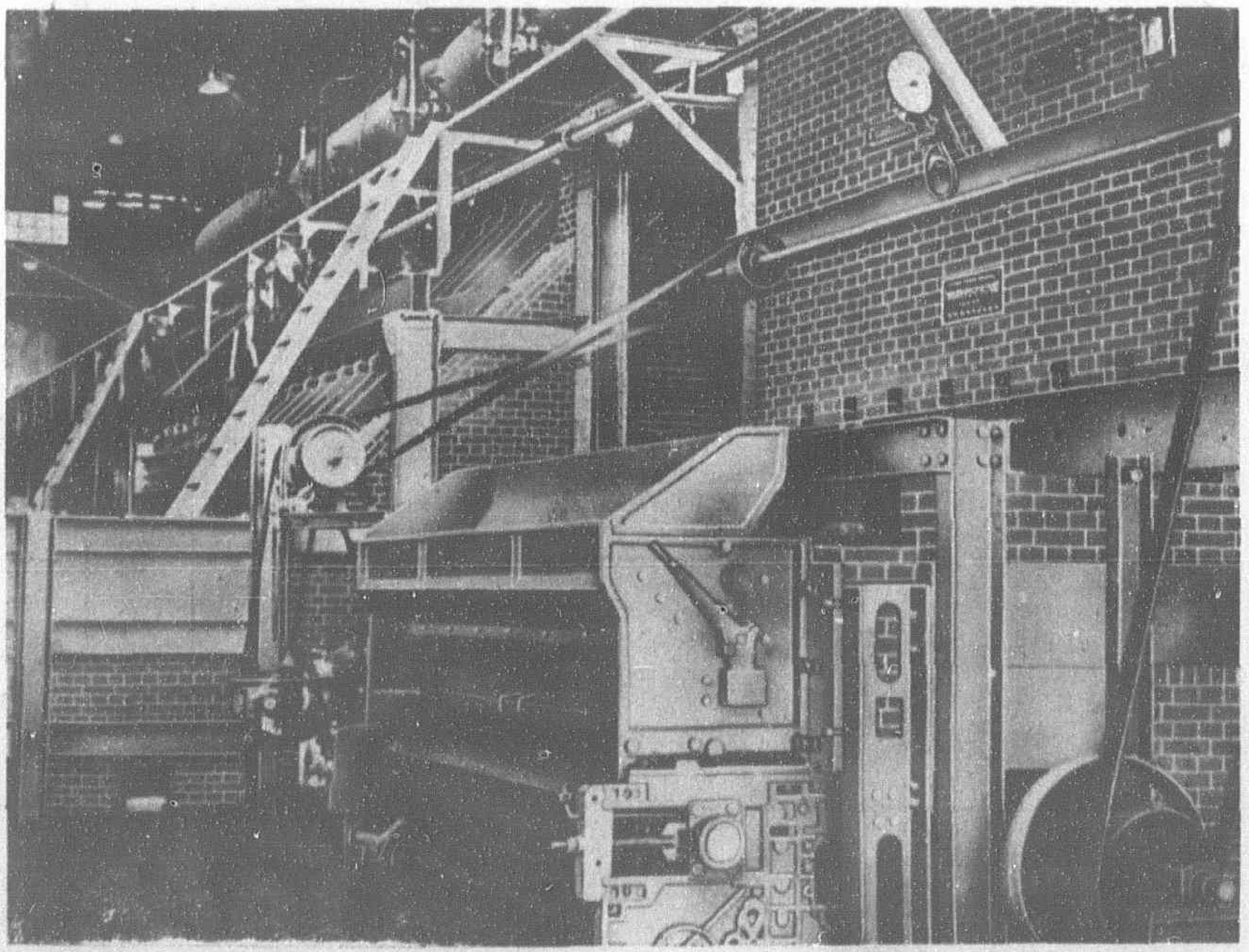
Built by the Kisha Seizo Kaisha of Osaka



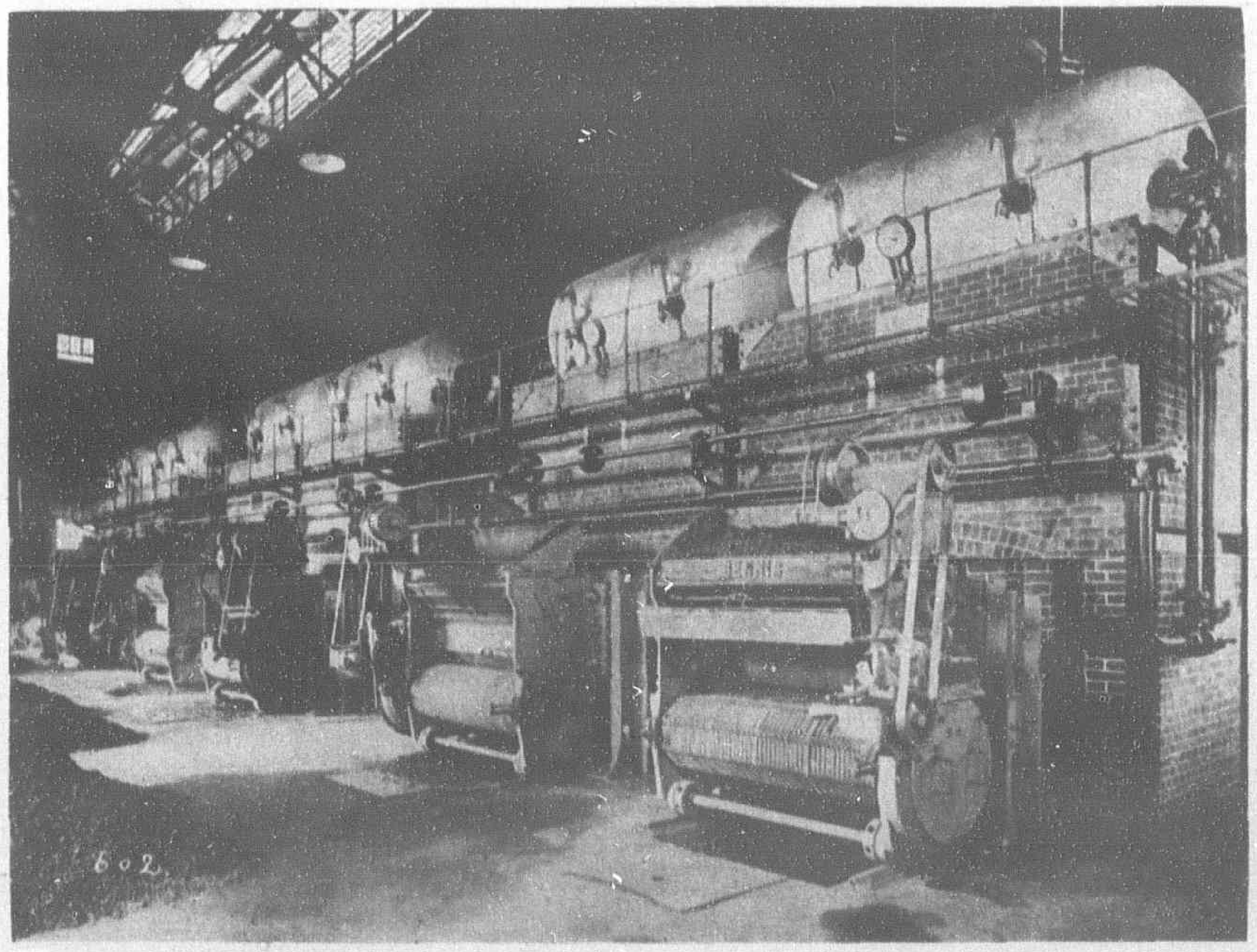
Four L-400 Takuma Boilers at Zeze Works of Asahi Kenshoku Co.



Six L-600 Takuma Boilers at Iwakuni Works of Teikoku Jinken Co.



Five L-500 Takuma Boilers at Wanri Works of Taiwan Seito Co., four fitted with bagasse furnace and one with stoker

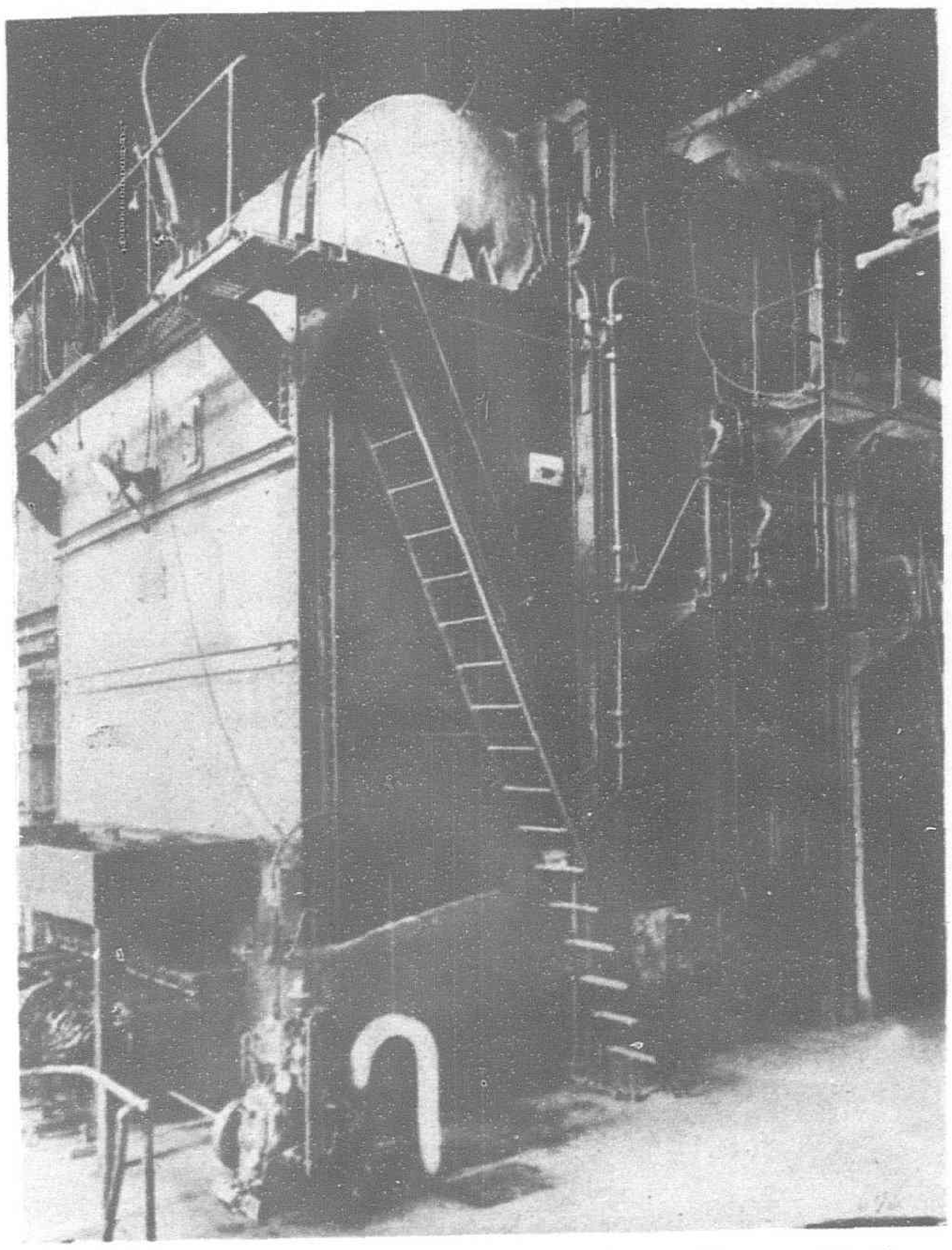


Six 250 Takuma Boilers at Hiroshima Works of Teikoku Jinken Co.

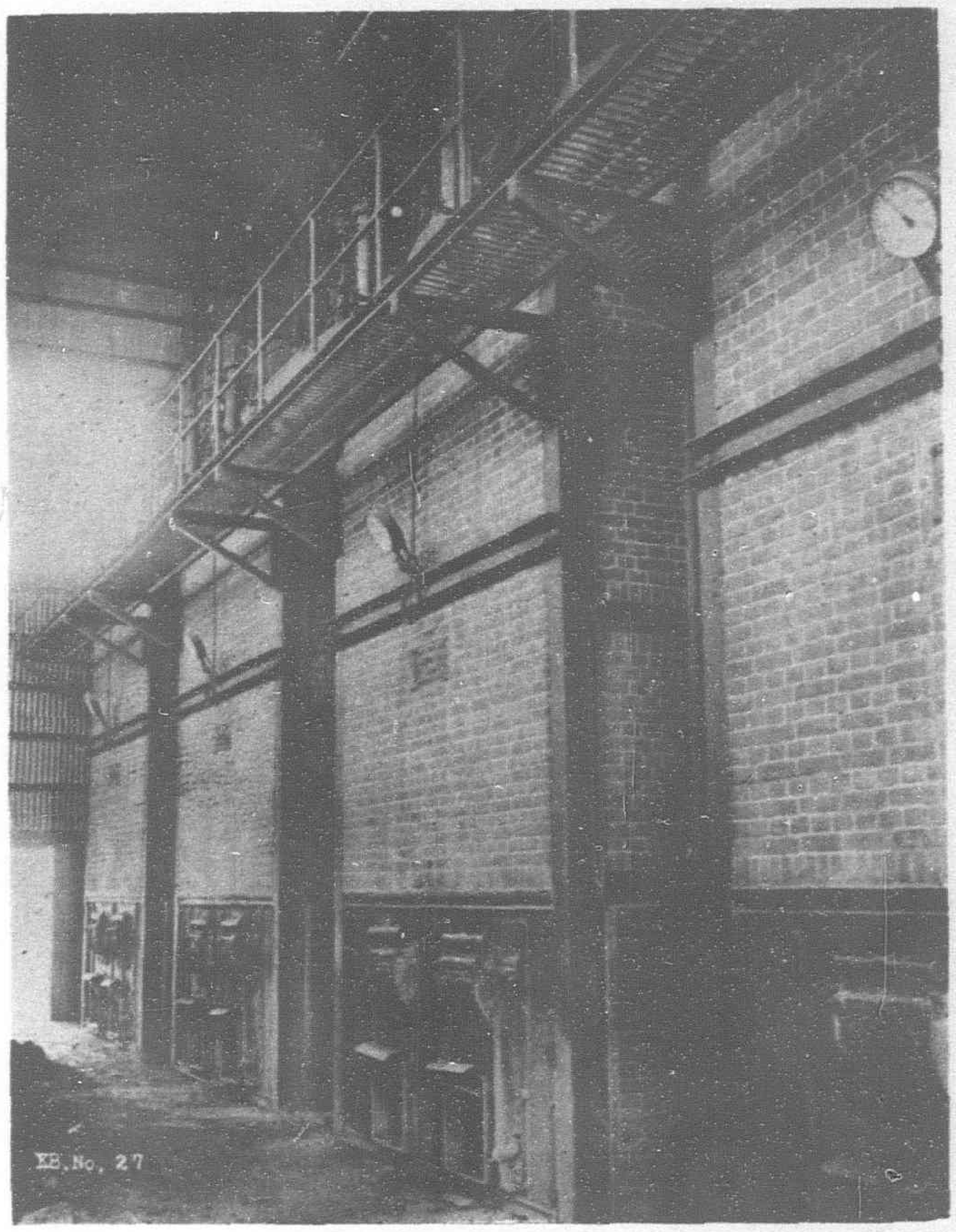
TABLE III. STEAMERS FITTED WITH WATER TUBE BOILERS

Name of Vessel	Gross Tonnage	When Launched	Service	Builder	Engine	I.H.P. or S.H.P.	Working Pressure lbs. per sq. in.	Boiler								Draft	Owner	Remarks
								Type	Number	Dimension of Drum		Grate Area sq. ft.		Heating Surface sq. ft.				
										In. Dia.	Length	Each	Total	Each	Total			
Matsume Maru	3,429	June 1924	Ferry bet. Aomori & Hakadate	Mitsubishi Zosen K.K. Nagasaki	Mitsubishi Geared Turbine × 2	S.H.P. 5,500	200	B. & W.	6	3′-6″	10′-2¾″	57.75	346.5	1,820	10,920	Sirocco's Closed Stokehold	I.G.R.	Fitted with Superheater Heating Surface. Each 344 sq. ft. Total 1,464 sq. ft.
Tsugaru Maru	3,484	May 1924	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	
No. 1 *Seikan Maru*	2,326	Oct. 1926	,,	Yokohama Dockyard Co. Yokohama	Brown Boveri Geared Turbine × 2	S.H.P. 2,200	,,	Ikeda	2	2′- 3″ 2′- 3″ 1′-11″	15′-0″§ 15′-0″ 15′-0″	76.5	153	2,900	5,800	,,	,,	Fitted with Superheater Total H.S. 1,200 sq. ft. Deg. of Superheat 128°F.
No. 1 *Kizu Maru*	1,216	Mar. 1911	Dredger	Uraga Dockyard Co. Uraga	Triple Expansion Engine × 2	I.H.P. 1,300	170	B. & W.	,,	4′-0″	15′-1⅛″	84	168	3,084	6,168	Natural	Department of Home Affairs	
Noda Maru	1,242	April 1912	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	
Yun Yang Maru	1,037	Jan. 1922	River Boat (Yangtze kiang)	Kiangnan Dock Co. Shanghai	,,	I.H.P. 2,900	250	Thornycroft	,,	†4′-0″ ‡2′-6″	10′-1⅞″ 10′-1⅞″	90	180	4,000	8,000	Closed Stokehold	Nisshin Kisen Co.	
Chang Yang Maru	1,033	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	
Iyang Maru	943	Dec. 1921	,,	,,	,,	I.H.P. 2,500	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	
Fon Ling Maru	621	Jan. 1929	,,	,,	Triple Expansion Engine × 1	*	,,	Yarrow	,,	*	*	*	*	*	*	*	,,	
Sanyo Maru	561	April 1923	Ferry bet. Uno & Takamate	Mitsubishi Zosen K.K. Kobe	Mitsubishi Geared Turbine × 2	S.H.P. 1,300	200	Ikeda	,,	2′- 3″ 1′-11″	9′-6½″ 9′-6½″	45	90	1,865	3,730	Sirocco's Closed Stokehold	I.G.R.	Fitted with Superheater Heating Surface. Each 366.7 sq. ft. Total 733 sq. ft.
Nankai Maru	561	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	
Hayabusa Maru	591	Jan. 1917	Car Ferry	Seabom Ship B. Co., U.S.A.	Compound Engine × 2	I.H.P. 300	250	Almy	,,	1′-2⅛″	6′-4″	22.6	53.2	844	1,688	Natural	Ikujiro Nakabe	
Kompira Maru	377	Dec. 1917	Private Ferry	Mitsubishi Zosen K.K. Nagasaki	Compound Engine × 2	I.H.P.	130	Narmond	1	†2′-6⅜″ †1′-4⅜″	9′-9¼″ 9′-9¼″	24	24	1,326	1,326	,,	Mitsubishi Zosen K.K.	

* Unknown § About † Top ‡Bot.



Two ML-530 Takuma Boilers at Changchung Power Station of South Manchuria Electric Co.



Four ML-240 Takuma Boilers at Chemical Works of Osaka Gas Co.

Water Tube Boilers for Land Use

Water tube boilers on land are principally used in steam power stations. While much of engineering records was lost through Great Earthquake and subsequent fire of 1923, it is almost certain that, Roots, Woodburry and New York Safety types were first water tube boilers introduced to this country in about 1892. In 1895, Tokyo Electric Light Co., Ltd. installed in their Asakusa Station eight Roots boilers. They were of 224 boiler horse power with working pressure of about 160 lbs. per sq. inch.

In 1901, Shibaura Engineering Works started the manufacture of "Miyabara" boilers. But this type did not succeed in creating much demand in the market, and, as years gone by, Babcock & Wilcox type began to show its prominence almost over this country. The first large installation of this type consisting of eight boilers of 320 H.P. each, was made, in 1903, by Tokyo Electric Railway Co., Ltd. in their Ohsaki station, near Tokyo.

By this time reciprocating engines for electric power generation were still being used, but since the first adoption in 1905, of 1,000 K.W. Parsons turbine by Tokyo Electric Light Co. in their Senju Station and of Curtis turbine of the same capacity in Yotsuyama Power Station of Miike Colliery, steam turbines became the standard prime mover in steam power stations, together with universal adoption of water tube boilers.

Table IV gives the types and numbers of boilers now in use in power plants, over 1,000 K.W. output, for general supply and electric railway service as well as for the other independent industrial purposes.

According to the above Table, while C. T. M. type of B. & W. boilers takes up only 10 per cent. of the total number used, its aggregate heating surface covers 21 per cent. of the total. This fact illustrates that large sized boilers of this type are becoming popular, owing to its capability of adapting itself, from its constructional reasons, to the requirements under overload working.

General trend of increase of heating surface of water tube boilers used in power stations, over 1,000 K.W. output, for general supply, electric railway service and other industrial purposes, is illustrated in Fig. 5. It will be seen from this Figure that 58,000 sq. ft. as was in 1907 has been increased to 5,430,000 sq. ft. in 1928, that is to say, to almost 100 times as much during the last 21 years.

TABLE IV.—TYPE OF BOILERS USED IN POWER PLANTS.

Type	Boilers for General Service and Electric Railway Plants				Boilers for Industrial Plants			
	H.S. sq.ft.	%	No.	%	H.S. sq.ft.	%	No.	%
Babcock & Wilcocks W.I.F.	2,113,273	57.6	428	64.9	1,082,726	58.8	266	60.9
Babcock & Wilcocks C.T.M.	785,123	21.3	66	10.0	34,885	1.9	5	1.1
Garbe	319,084	8.7	82	12.4	139,310	7.6	33	7.6
Heine	279,255	7.6	55	8.3	53,247	2.9	16	3.7
Erie City Vertical ..	113,382	3.1	17	2.6	97,263	5.3	21	4.8
Edge Moor ..	—	—	—	—	217,929	11.9	26	5.9
Stirling	—	—	—	—	87,854	4.8	19	4.3
Mitsubishi Nesdrum	48,000	1.3	8	1.2	32,159	1.8	11	2·5
Takuma					24.131	1.3	9	2.1
Others	16,694	0.4	4	0.6	68,751	3.7	31	7.1
Total	3,674,811	100	660	100	1,838,255	100	437	100

Remarks: Boilers in this table do not include those for plants under 1,000 k.w. capacity.

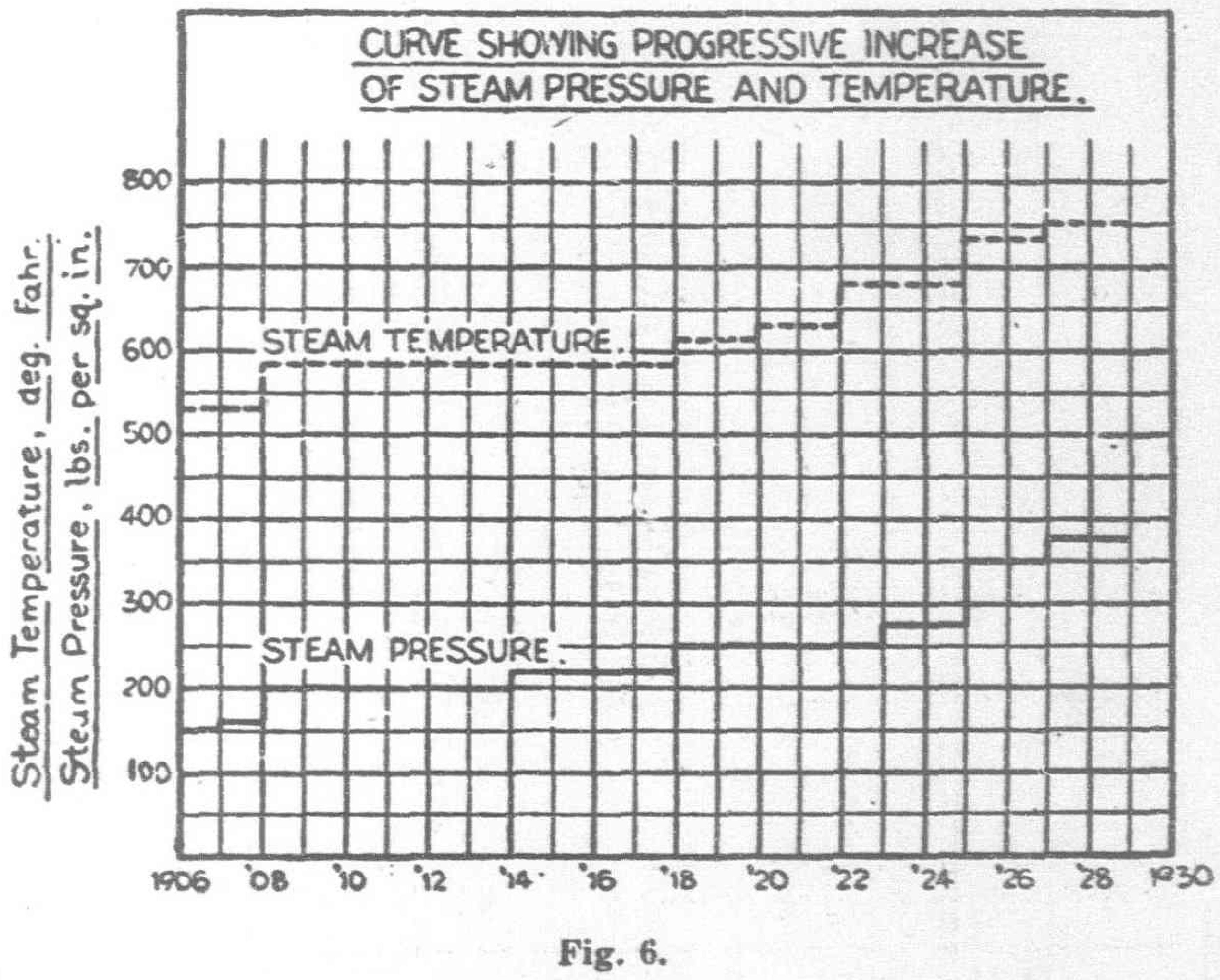


Fig. 6.

Both the pressure and temperature of steam have been steadily increased, during the same period, following the improvements made in design and materials used in construction of turbines and boilers. The thermal efficiency of plants was thereby much elevated which resulted in the reduction of the rate of consumption of fuel and consequently the generating cost of electricity.

As is clear in the diagram herewith attached, the pressure of 220 lbs. at the temperture of 580° F. in 1917 was raised, in the following years, to 250 lbs. which was adopted in the Kokura Power Station of Kyushu Electric Railway Co., and, in 1923, was raised further to 275 lbs. at the Amagasaki Power Station of Nippon Electric Power Co., thence raised still higher to 350 lbs. at an elevated temperature of 738° F. by the establishment, in 1925, of Nagoya Station of Toho Electric Power Co., and finally was raised, in 1927, to 375 lbs. at 750° F. at the Tsurumi Power Station of Tokyo Electric Light Co.

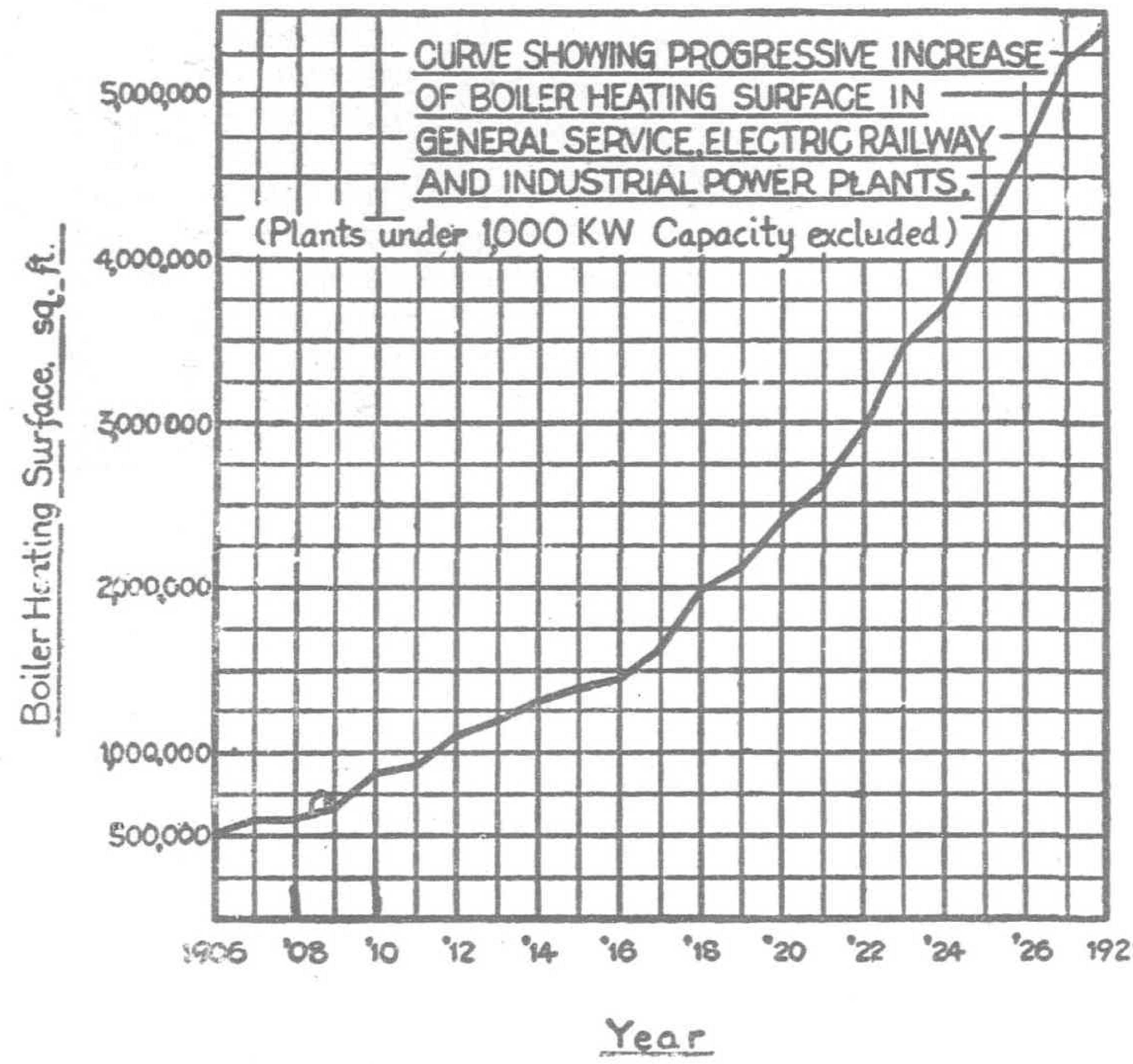


Fig. 5.

Of the steam used now-a-days in Japan, the highest in working pressure is 375 lbs., and, in its temperature, 752° F., reached in the power station of Nankai Railway Co., Ltd. But there are new projects now under consideration, where steam of 650 lbs. and 1,200 lbs. will be used.

For the efficient utilization, however, of such super high pressure steam, reheating is an absolute necessity, and the reheat boilers equipped for this purpose are liable to cause trouble. Even in the United States where super high pressure steam has been in use for the past several years, considerable difficulties are still being experienced in manipulating them properly. Such difficulties will be more prominent in this country, where load condition on steam power station varies so suddenly and frequently, on account of the fact that hydro-electric plants are generally taking care of base load. It is, therefore, hoped that by the time when power plants now projected come into their realization, manipulation of reheat boilers corresponding to varying load conditions could be properly accomplished, through better knowledge and experience gained by the operation of existing plants.

Table V serves to give a concise idea of boiler equipments in a few of representative power stations of large capacity.

As will be seen from the above Table, most of the boilers in recent power stations are of C.T.M. Type of Babcock & Wilcox make, and many boilers planned to be installed in plants of large capacity now being projected are of the same type designed for having, in single unit, heating surface ranging between 1,300 and 1,800 sq. ft.

In many of existing large power stations, regenerative feed heating system, which utilizes extracted steam from turbines, is adopted to a large extent, and economisers of fairly large capacity are equipped as well. However, there is no power stations, as yet, where air preheaters are used, except in some of large plants now under construction or being projected.

Fuel coals in this country are generally bituminous coals of comparatively inferior quality. The Table VI shows representative varieties now in use as fuel for power generation.

TABLE VI.—ANALYSIS OF REPRESENTATIVE COALS OF JAPAN.

Field	Proximate Analysis, Per Cent. Moisture	Volatile Matter	Fixed Carbon	Ash	Heating Value B.T.U. per lbs.	Caking Property
Onoura, Kyushu ..	8.95	26.61	50.84	13.60	12,300	weak
Meiji, ,, ..	6.30	34.10	44.80	14.80	11,530	—
Horonai, Hokkaido ..	7.98	37.12	41.50	13.40	11,600	—
Iriyama, Iwaki ..	11.00	28.50	41.50	19.00	10,839	—
Fushun, Manchuria ..	8.52	36.58	46.36	8.54	11,300	weak

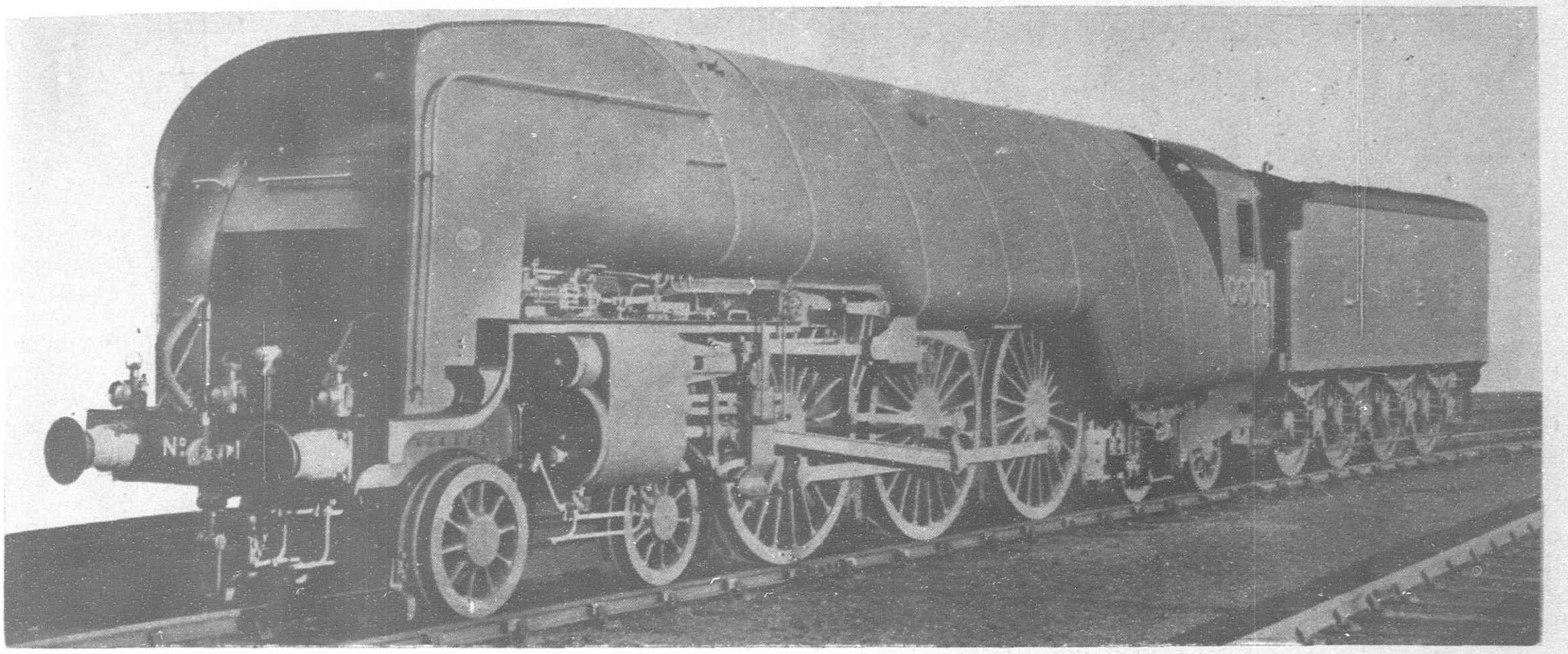
As will be seen from the analysis contained in the above Table, they are generally high in percentage of volatile matter compared with fixed carbon contents and burn with long flame. The ash content in certain varieties reaches as high as 30 per cent. and it clinkers quite easily owing to its fusibility at low temperature. The calorific value of many of these varieties range between 10,000 and 12,000 B. Th. Us.

Fig. 7 shows the variation of average rate of consumption of coal per K.W.H. in principal power stations which have delivered more than 10,000,000 K.W.H. annually for general use or electric railway service. From this curve, it is seen that the consumption of 4.6 lbs. per K.W.H. in 1918 was reduced to 2.5 lbs. in 1927. It may be considered a remarkable improvement as far as the

TABLE V. BOILER PLANTS FOR TYPICAL POWER STATIONS

Name of Power Co.	Name of Station	Total Generator k.w.	Boiler Type	Pressure lb./sq.in	Temperature F°	Heating Surface sq. ft.	No.	Economizer Heating Surface sq. ft.	No.	Type of Stoker
Nippon Electric Power Co.	Amagasaki	140,000	B. & W. C.T.M.	275	634	10,821	4	4,476	4	Riley Underfeed
			,,	,,	,,	,,	,,	,,	,,	Lopulco Pulverized
			,,	,,	,,	13,467	,,	5,570	,,	Compartment Chain Grate
			,,	,,	,,	,,	,,	,,	,,	Lopulco Pulverized
Ujigawa Hydro-Electric Co.	Kizugawa	60,000	,,	375	692	15,319	8	4,350	16	Riley Underfeed
Tokyo Electric Light Co.	Senju	75,000	,,	275	626	10,821	12	4,476	12	Compartment Chain Grate
,,	Tsurumi	70,000	,,	375	750	18,621	4	8,962	4	,,
Toho Electric Power Co.	Nagoya	70,000	,,	350	738	,,	,,	8,870	,,	,,
Daido Electric Power Co.	Kasugade No. 2	40,000	B. & W. W.I.F.	225	622	6,182	32	2,040	32	Chain Grate
Ujigawa Hydro-Electric Co.	Fukusaki	40,000	Erie City	250	631	7,077	10 }	4,915	} 13	Riley Underfeed
				260	634	7,280	3 }			,,
			Garbe	,,	,,	8,615	1	5,700	1	Holbeck Pulverized
Toho Electric Power Co.	Najima	40,000	Erie City	250	606	5,143	4	6,180	2	Riley Underfeed
			B. & W. W.I.F.	,,	,,	7,719	,,	5,200	,,	Chain Grate
			,,	,,	,,	8,019	1 }	2,000	4	Compartment Chain Grate
			,,	,,	,,	,,	1 }			Lopulco Pulverized
			B. & W. C.T.M.	275	644	13,467	2	5,570	2	Compartment Chain Grate
Nankai Railway Co.	Sakai	33,500	Garbe	320	752	13,988	5	7,200	5	Travelling Grate
Hiroshima Electric Co.	Saka	25,000	B. & W. C.T.M.	330	720	11,724	4	6,714	4	Compartment Chain Grate

(Continued on page 237).



London and North-Eastern Railway Express Locomotive, No. 10,000 Fitted with a Yarrow-Gresley Patent High Pressure Water Tube Boiler Operating at 450 lbs. per sq. inch Working Pressure. Constructed by Yarrow & Co., Ltd., Glasgow

L.N.E.R. "Hush-Hush" Express Passenger Locomotive

No. 10,000, the latest locomotive to be completed for the London and North Eastern Railway Company's passenger service between Scotland and England, is arousing considerable interest and its outstanding feature is the boiler which adheres closely to the well known Yarrow design. The Yarrow Boiler has been almost exclusively adopted for naval purposes for many years, is widely used for all industrial purposes on land, and is fitted in all the latest large steamships, so that its installation on a railway engine can hardly be called an experiment.

In its original form the Yarrow Water-tube Boiler consisted of a saturated steam drum and two water drums interconnected by tubes. The saturated steam drum formed the apex of a triangle with tubes at each side, the water drums being placed at each end of the base. No. 10,000 really embodies two Yarrow boilers on this principle but with a common saturated steam drum extending for practically the whole length of the engine. Immediately in front of the driver's cab and extending for about one third of the engine length are two water drums placed as widely apart and as low down as possible, into which are expanded rows of tubes from the saturated steam drum. A large combustion chamber surrounded by water tubes is thereby formed, triangular in section and having grate bars as base.

The middle third length of the engine houses two other water drums placed as low down as possible but close together, so that no combustion space is left between the nests of tubes, these making really a second boiler common to the steam drum.

Combustion is completed in the large furnace referred to above and as a large proportion of the boiler surface is exposed to the fire, the maximum amount of heat is absorbed by direct radiation, by far the most effective means of heat transfer. Leaving the furnace the gases traverse the tubes of the second boiler, giving up their heat by convection.

In the large smoke box a superheater of special design is fitted.

The outside boiler casing has been built to the extreme limits of the railway gauge and the chimney has been sunk within steel plates arranged to deflect the air and so throw the smoke upwards clear of the driver's view from his position on the foot plate. An inner casing entirely encloses the boiler and with the outside casing forms an air space through which the whole of the air for combustion passes on its way to the grate, special openings to the double casing being provided at the front. As it travels therefore the engine scoops in all its air which becomes preheated as it flows through the double casings and prevents radiation loss form the outside plating.

Although these features may be novel to a railway engine they have been embodied for many years on industrial steam raising plants and very extensively at sea.

Considerable experimenting was undertaken, and the new outstanding design was arrived at by tests which were made with a model of the locomotive in a wind flume, with air currents of speeds up to 50 m.p.h.

The locomotive possesses the unusually high boiler pressure of 450 lb. per sq. in., which is the highest pressure which has ever been used for a British railway locomotive. This high pressure has necessitated the use of a boiler of the water-tube type which has never previously been applied to a locomotive. The object of using high pressure is fuel economy.

The new engine possesses a wheel arrangement, 4-6-4, or "Baltic" type, this being the first tender locomotive with this wheel arrangement to be constructed and operated in this country. The six coupled driving wheels are 6 ft. 8 in. in diameter. One of the most striking features is that the whole of the air supplied to the firegrate is preheated, the supply being taken from the front of the smokebox, passing down a space between the boiler and the casings.

The engine is a four-cylinder compound. The two high-pressure cylinders, which are made of cast steel (a new feature), are 12 in. in diameter and 26 in. stroke, driving on to the leading coupled wheels. The two low-pressure cylinders are situated outside the frames and drive the intermediate pair of coupled wheels. They have a diameter of 20 in. and stroke of 26 in.

The new engine has been constructed entirely of British steel, by British workmanship, at Darlington, to the designs and inventions of Mr. H. N. Gresley, C.B.E., Chief Mechanical Engineer of the London & North Eastern Railway Company.

No name has yet been given to this "Hush-Hush" engine, which, after trials, is to be tested in the service between London, King's Cross and Edinburgh, Waverley. The engine is the longest and heaviest passenger locomotive in Great Britain, weighing, with its tender of the well-known corridor type, nearly 170 tons.

Water Turbine Development in Japan—II

By MASATAKA TAZAWA, Director, Dengyosha Prime Mover Works, Ltd., Tokyo

XII.—Distribution of Hydro-electric Plants in Japan and Their Generating Capacity

The average output of a hydro-electric plant in Japan stood at barely 120 horsepower per set in 1892, when the first power station was installed in the country. Because of the fact that the chief purpose of these plants was to produce electric energy for lighting purposes, the per set output was never in excess of the 500 horsepower mark for the succeeding twelve to thirteen years for which the short distance of transmission obtaining for most of the sets, was also partly responsible. As the number of installations increased later the average output rose to 1,000 horsepower or its multiples. Nevertheless, for some time, even though the largest unit had an output in the neighborhood of from 3,000 to 4,000 horsepower, there never was a hydro unit in operation which was capable of a 10,000 horsepower production.

The electric lighting service later made tremendous strides in big cities as well as in numerous minor communities, in all parts of the country. Electric power needs for illuminating purposes, however, were greater in Tokyo than most large cities. In view of the fact that the metropolis is situated in the vast Kanto plain, its power site had to be located on some stream at some distance from the center of consumption. This fact was responsible for the first high voltage power transmission system being established in this part of the country. The Tokyo Electric Light Company, which supplies the electric light needs of the capital, erected power generating plants on the river Katsuragawa which has its source in the Chichibu mountains to the northwest of Tokyo. These plants had several sets of turbines each capable of an output of 5,000 horsepower, thus establishing a record in Japan for large output installations.

During the succeeding eight years, several large capacity power stations have been started in the surrounding country with Tokyo as the chief center of consumption. For instance, the Kinugawa Hydro-electric Company established its plant on the River Kinu which flows along the territory where Nikko, noted for its beautiful mausoleum, is situated. The Katsuragawa Hydro-electric Company tapped the Katsuragawa River which has the glacier of Mount Fuji as its solid reservoir; while the Inawashiro Hydro-electric Company harnessed a flow from Lake Inawashiro a well-known natural and permanent reservoir. All of these plants had numerous turbines within the 10,000 horse-power class. The above enumerated four power plants were large scale turbine installations, and were typical of Japanese plants at that time.

Sometime later the Ujigawa Hydro-electric Company installed an 8,000 horsepower turbine on Lake Biwa, for the purpose of supplying electricity to the large consuming center of Osaka. Since that time, and until the outbreak of the World War in 1914, such a large output turbine was not installed again, and even during the war years, when the hydro-electric industry had undergone a tremendous expansion, the instance of a 10,000 horse-power turbine installation has never been recorded, the majority of the many newly started plants being equipped with turbines in the 3,000 to 4,000 horsepower class.

An explanation for this probably lies in the fact that these electric utility firms were generally in great haste for the acquisition of machinery and its installation, to supply the most urgent needs of the chemical, iron and steel and other industries, whose usual sources of supply had temporarily been cut off, because of the transportation difficulties or other handicaps caused by the war. Power firms, under these circumstances, naturally hastened to obtain results. They wanted to lay down the necessary foundation for their respective business before the restoration of peace. Large capacity units necessarily required large-scale civil works, taking a comparatively long time for completion, thereby jeopardizing a full enjoyment of the war time prosperity. They chose such hydro sites as could be developed within the shortest possible period of time and in the simplest possible manner.

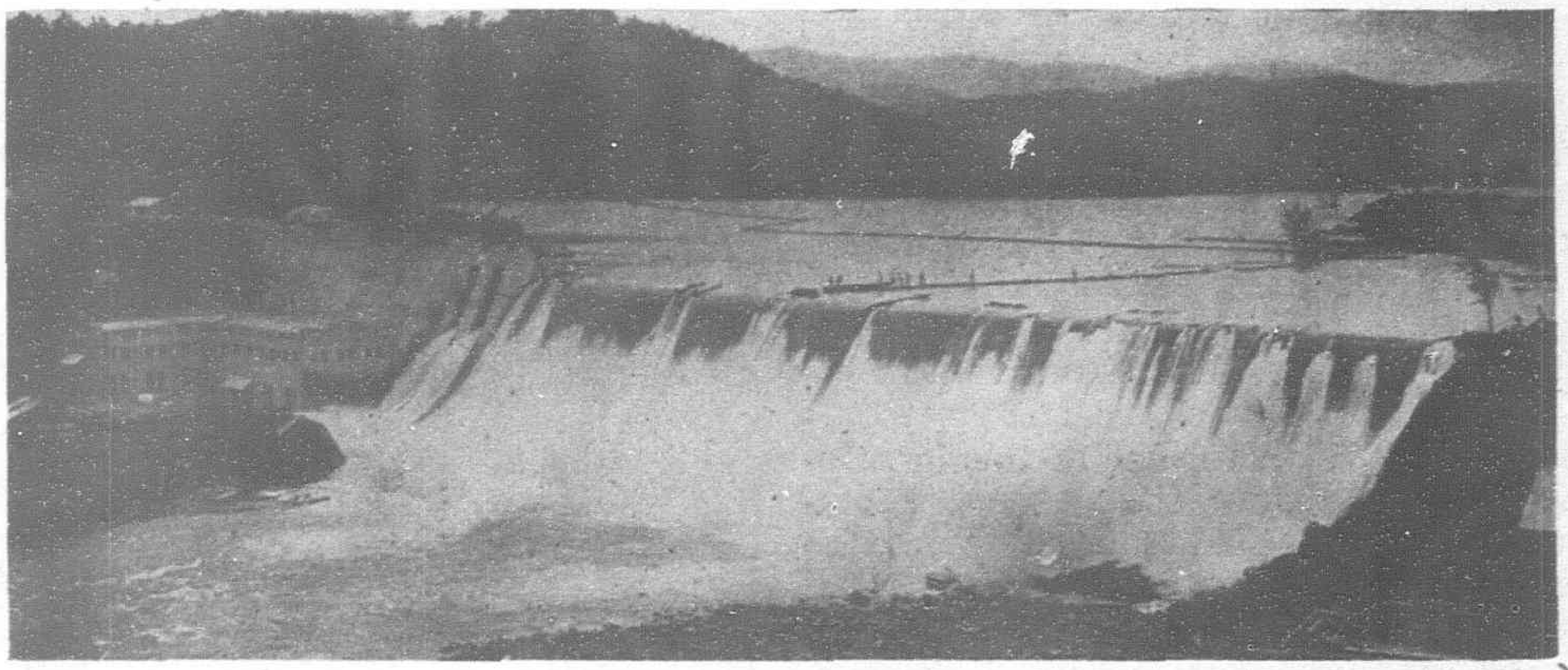
When the war terminated, the enormous amount of wealth accumulated during the four years of unexpected prosperity could not be checked, and the flow of capital, which had hitherto been confined to "quick result" enterprises, was now shifted to undertakings of a more permanent and conservative character. Power executives now turned their attention to the vast potential electricity needs of such large metropolises as Tokyo, Osaka and Nagoya. About this time the effectiveness and dependability of a long distance transmission of current, under extra high voltage, was fully demonstrated and it was considered a feasible plan to connect the above mentioned three cities by such transmission systems, into which to conduct an enormous volume of electricity. This electricity could be generated by tapping the extraordinarily ample hydro resources represented by the various flows, having their sources in the Japan Alps, whose adjacent valleys the transmission lines had to traverse. The eyes of hydro executives were now focussed on these power projects developed one by one, equipped with turbines in the 40,000 horse-power class, making the previous record of 10,000 horsepower appear as a mere nothing. Many power plants which are located in the mountain range popularly known as the Japan Alps, are well-known for their output, to say nothing of holding the record of being the biggest power producers in Japan. These units belong to the Daido Electric Power Company, the Japan Electric Power Company and others.

The aggregate output of all hydro plants now in operation, and ready for operation within a short time, stands approximately at 4,500,000 horsepower. The distribution of these power plants has a close relation to the geographical condition and population density of the country. The central part of the mainland of Japan because of its contiguity to such large consuming centers and points of large population as Tokyo, Osaka, Nagoya, etc., and because of its richness in hydro resources in the Japan Alps, claims the largest percentage of water power electric plants of the entire nation. While its per unit output is comparatively small, Kyushu boasts of a cluster of smaller power plants which contribute no mean aggregate production of electricity. It is of striking interest to note that this particular region of Japan, which is noted for its abundant deposits of coal, should also have the distinction of being the best electrically developed territory in Japan, next only to the central mainland; but the motive of the promoters of these hydro-electric undertakings in Kyushu cannot be otherwise than to conserve the limited fuel resources for the best interests of the country, from a national and industrial viewpoint, by harnessing the comparatively abundant water resources of the region. This step certainly in a sensible one.

XIII—Foreign Makes Dominate the Large Capacity Turbine Market; Competition Among Foreign Suppliers.

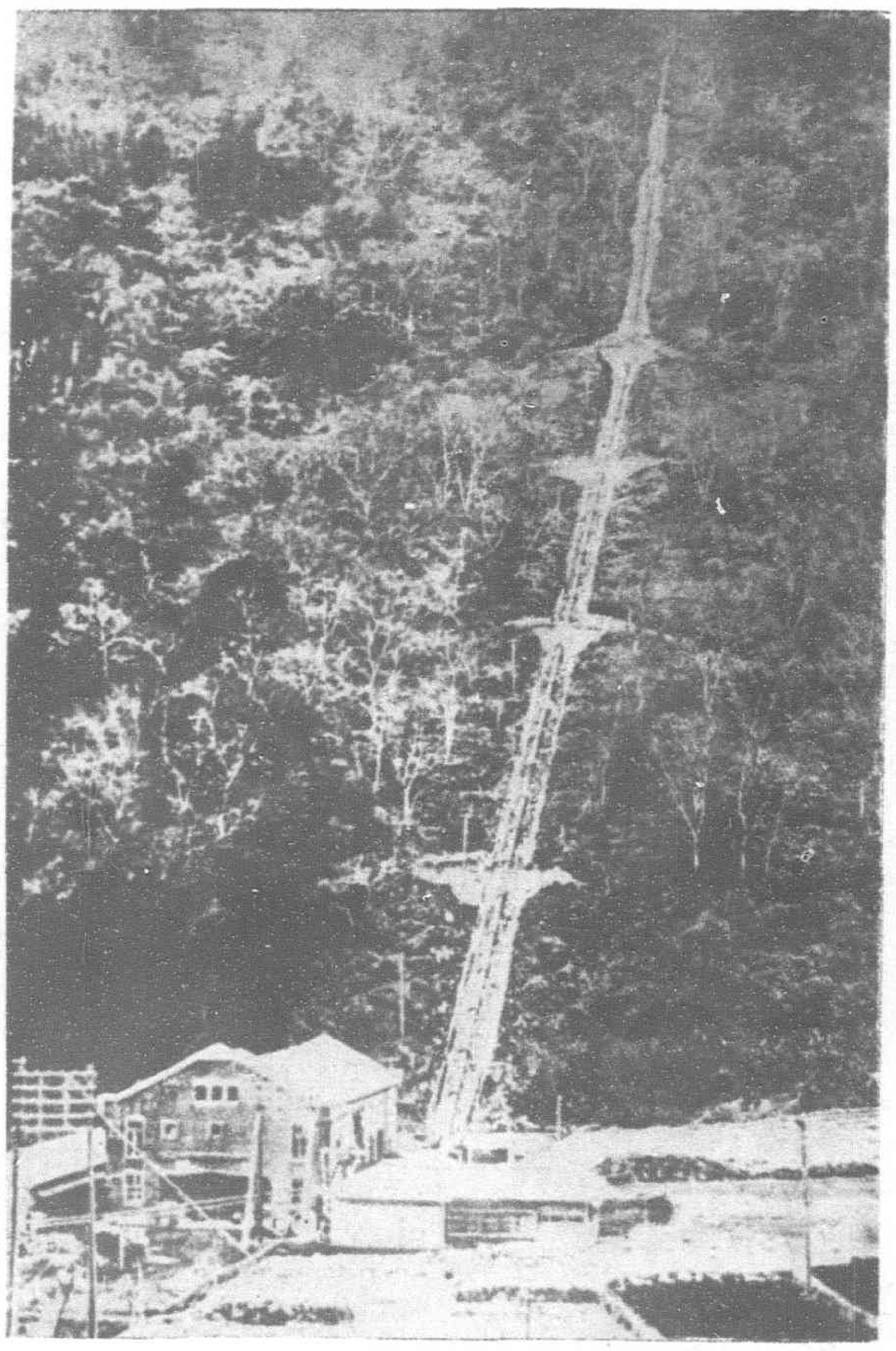
An over-supply of imported water turbines swamped our markets as manufacturers of Europe and America began to hustle in their mad effort to regain their pre-war market status. They were most successful in securing nearly all large capacity turbine orders that there were in the market, and home turbine firms were not allowed to participate in this business even to a modest degree; their wartime helpfulness to hydro-electric companies in the latter's hour of need was entirely forgotten and passed unrewarded. Swiss manufacturers were the most successful in this competition for the turbine business, which was on one of the largest scales ever seen in this country. They captured the lion's share, with America coming second. As mentioned before, German turbine houses fared very poorly in this contest, their dominant position in the Japanese market of pre-war times being snatched away by rivals. In fact, the volume of business booked by German firms even lagged behind their Swedish competitors. The secret of the Swiss success can be entirely attributed to selling price.

The fact that American suppliers of turbines came out fairly successful among all competing foreign firms, despite their gen-



(11) A view of the hydro power station of the Fuji Paper Manufacturing Company on the River Sorachi, Hokkaido, equipped with Densyosha water turbines and all-Japanese machinery

erally excessively high bids is ascribable to the influence directly or indirectly exerted by the American investment bankers handling dollar loans for many Japanese power utility firms, on behalf of American turbine manufacturers. These Japanese hydro concerns were grateful to American bankers for financial benefits given them at a time when long term loans of large amounts were most difficult to secure, and, consequently, they would rather buy American turbines, even if their prices were much higher than those of other countries. Japanese power executives felt it proper to buy turbines from the factories of the country where their loans were raised. While this was undoubtedly the principal motive for their partiality to American hydro units, the business sagacity of the borrowing concerns no doubt had a great deal to do with it. Perhaps they deemed it wise to purchase machinery and equipment from big American suppliers as they should impress underwriters and investors of their securities in the United States than would be the case when they bought from other countries. The surprisingly poor showing of German manufacturers, completely surrendering their former dominating influence, was attributable in part to the feeling of apprehension entertained by Japanese hydro power executives, as to the successful execution of turbine orders by manufacturers of the post-war Germany, encumbered, as they were, by countless economic ills to hamper all industrial activities. Competitors from other foreign countries saw to it that this psychology of the purchasers was taken full advantage of in such a way as to turn business in their favor.



(6) The power station of Mt. Hakone Scenic Railway equipped with a more advanced type of Dengyosha water turbine. (March 1918) Head 660 ft. 2,000 H.P.

XIV—Setback to Foreign Turbine Makers and Comeback of the Japanese Manufacturer.

But trouble was brewing for some of the foreign turbine manufacturers, who were most successful in the recent selling competition. It is characteristic of turbine orders that, unlike other machinery, their manufacture is according to a plan, specially drawn up by experts, based on detailed requirements furnished by the hydro-electric firm. The finished product, however, cannot be tested for running until it is delivered to the purchaser and installed at the particular water site for which it was built. This is very much like a newly built steamer that cannot be tested before launching. When a turbine is found to function unsatisfactorily after installation, regardless of how carefully it was designed and built, the prestige of its manufacturer falls overnight, never to be regained. Some foreign makers, responsible for numerous hydro-units installed in various parts of the country, over an extended period of time, saw their days of installation tarnish their reputation in no small measure. The deep-rooted confidence of the hydro-electric industry of the country in imported turbines was now shaken, and home turbine makers were again called upon to repair the faulty imported machinery. This repair work was done successfully. The upshot of it all was that Japanese turbine makers were again in the saddle to capture business for units of 10,000 horsepower or more, and as all deliveries functioned splendidly, without exception, new business came their way, a godsend, indeed, to the much tried home manufacturers.

At the same time the sentiment of patronizing home-made products was spreading fast and wide, and the turbine manufacturing industry was favorably affected by the movement. Since this time no hydro concern has tried to use imported units of below 10,000 horsepower, and a large share of the turbine business over 10,000 horsepower has been going to Japanese manufacturers. It looks almost certain that within a few years, the entire turbine needs of the country, in all output range, will be supplied by the factories located within the country.

XV—Changes of Turbine Types and Effect of American Wheels on Japanese Design.

The foregoing is an outline of the evolution of the water turbine in this country. We will now see how the type of turbine has changed at every stage of its development, and later will estimate the merit of imported turbines from the viewpoint of Japanese turbine makers.

About forty years before the traditional wood-constructed and wooden-shafted water wheel of Japan was transformed into the so-called foreign type, a comparatively large number of Pelton wheels employed to a sprinkling of reaction turbines, and home manufacturers followed this example. Since 1897 or thereabouts the horizontal reaction turbine came into vogue. This machinery came either in the open flume type or as the plate case turbine, and its striking shape excited the curiosity of hydro executives and experts. Because of the fact that the majority of these turbines were of American make, there was a difference in size only in accordance with their different output capacity, their type and shape being standardized.

Since 1902 European makes began to appear on these shores. All these units had horizontal shafts; and the vertical shaft equipped turbines were in the minority. As a rule, a cast iron spiral turbine was supplied for medium head, a frontal turbine for low head and a Pelton wheel for high head. As time went on, however, a great change took place in the method of construction, and the familiar tank-like shape gave way to a full-fledged machine-like appearance. The coupler connecting the dynamo became well proportioned, in harmony with the rest of the unit, but the essential feature of its horizontal type was retained.

By far, the majority of steam turbines imported at that time were the vertical shaft Curtis; and the floor plan of the steam and the water units was vertically opposed. Within a few years, in order to lessen the vibration and other inconveniences, the vertical shaft in the steam turbine was abandoned in favor of the horizontal shaft, to create the impression that the horizontal shaft system was the only formula for machinery which is driven by a single shaft. In hydro turbines, however, a phenomenon of an opposite character was developing. The introduction of American water turbines was the signal for the horizontal shaft in a water turbine being transformed gradually into the vertical shaft.

As a matter of fact, the stock article which American turbine manufacturers used for advertising purposes was the large output unit suitable for a medium head. A turbine of this description almost always had a vertical shaft, and the standard accommodation in the hydro plant was the vertical type. This practice was ingrained in the heads of hydro executives so that the vertical type was used under all circumstances. This was so even in the case of a high head, when the horizontal shaft type was most suitable, if not for the large output turbine. Within the three or four years after the ending of the World War, all hydro plants were adopting the vertical type in striking contrast to the tendency in steam turbine construction, which fact was most surprising. Chart 1 shows these tendencies in detail.

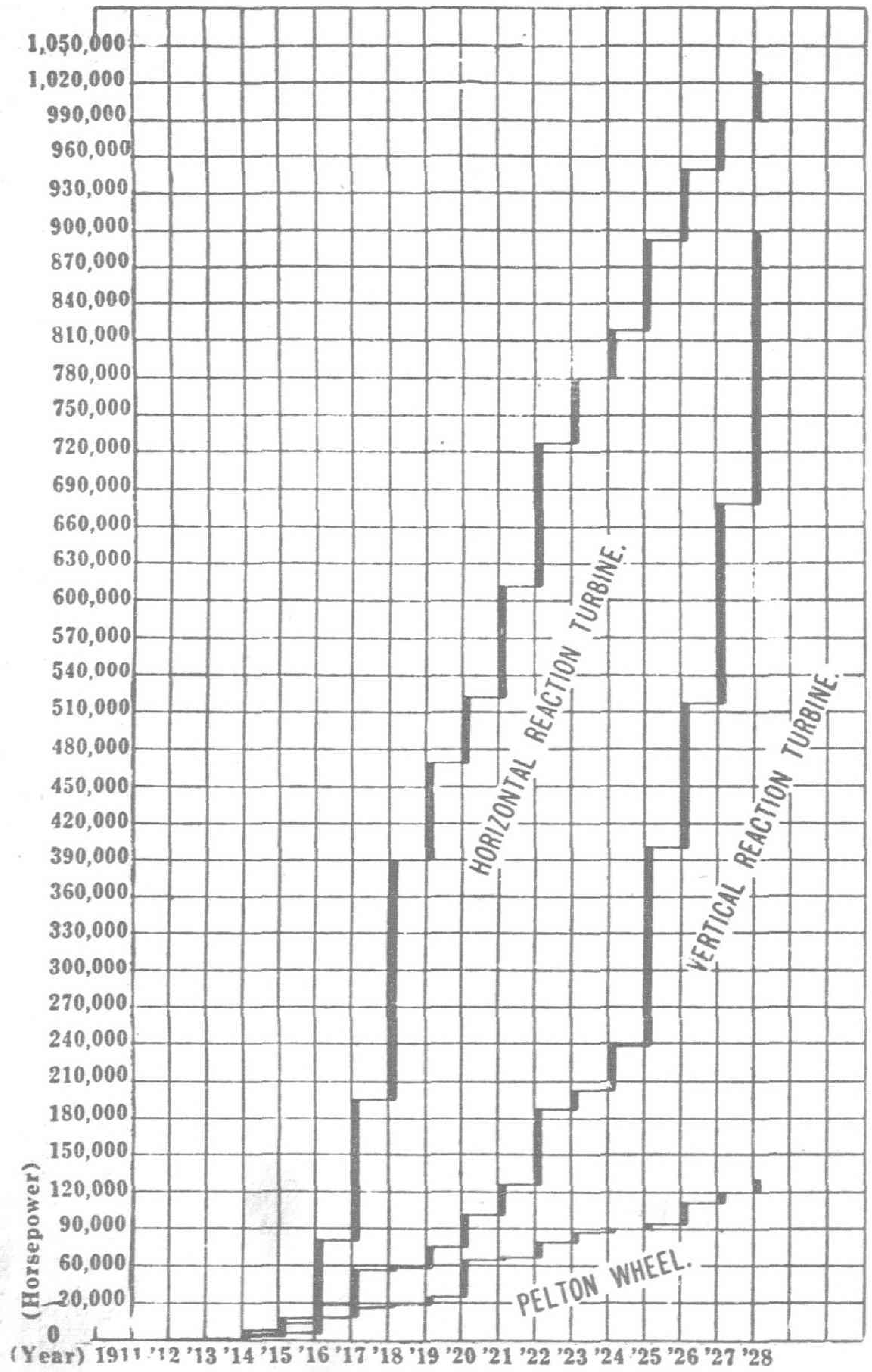


Chart 1.—Yearly Turbine Production by Japanese Manufacturers Compared by Types, Showing the Ascendancy of the Vertical Unit

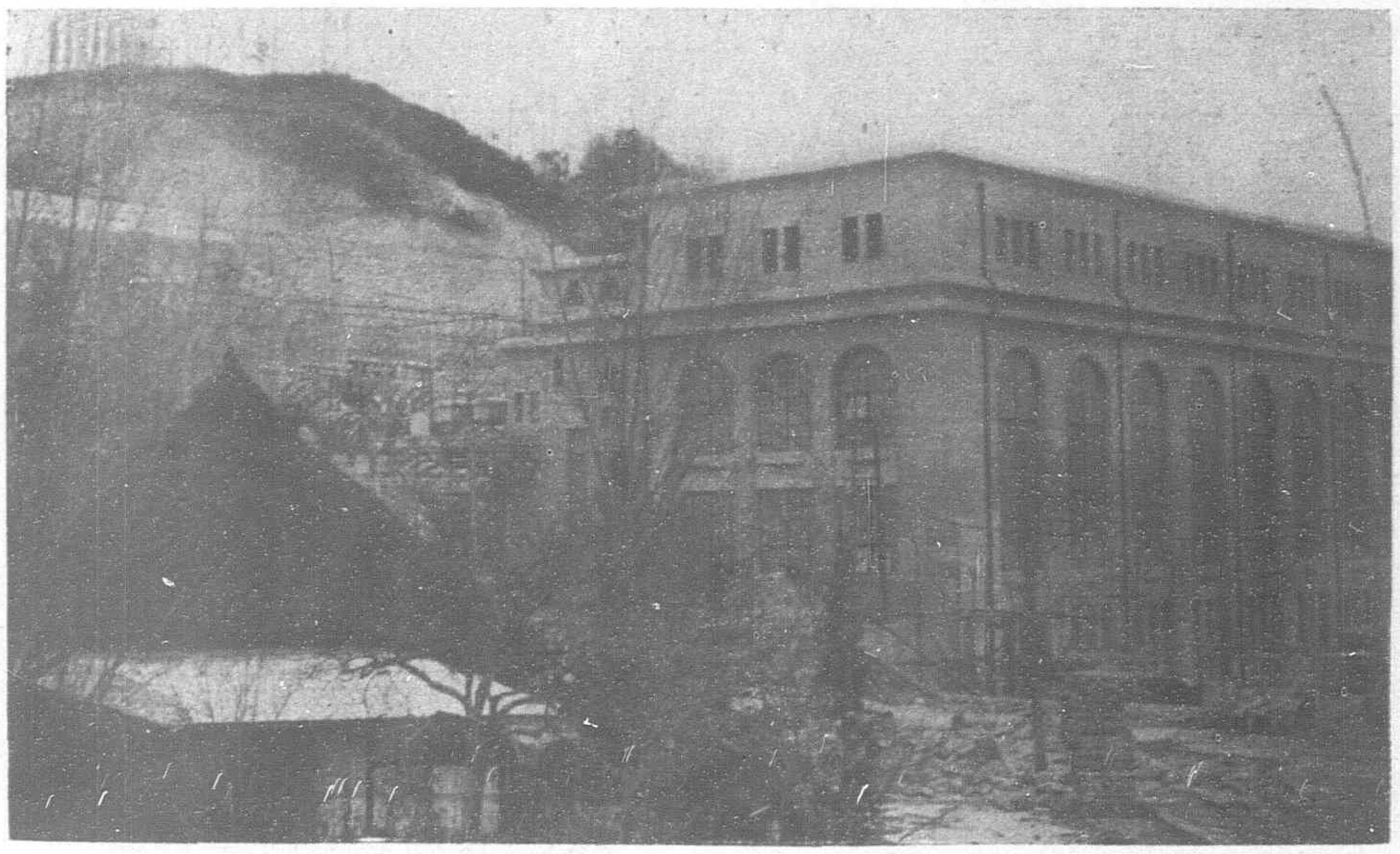
XVI—How Our Hydro Firms Select Their Turbines: and Competition Among International Makers.

The attitude of a hydro company, when making a selection of the turbine to be used for a newly started enterprise, has undergone a great change within a few decades. During the initial period following the advent of the hydro electric power industry into this country, capitalists as well as technical experts in their employ, were not very well informed in hydro knowledge to make their own independent choice, based on intrinsic merit. They necessarily followed the line of least resistance, by imitating in a wholesale manner what others were doing. If a foreign maker of turbines succeeded, through the medium of an importer, in placing his machine with a hydro concern, and if he followed this up with clever publicity, he was sure to secure all the turbine business there was in sight. Because of the negligible number of competitors opposing him, he could always name and obtain his own price for the products. Within ten years of the inauguration of the hydro-electric industry, Europe was taking the place of America as the chief source of turbine supply, but since Germany and Switzerland were virtually the only countries in this business, competition was by no means acute. Under these circumstances, an incentive was lacking for the manufacturers to introduce improvements into their machines, and their market values suffered little fluctuation. For some time, the manufacturers of Germany and Switzerland were having things all their own way.

(8) A power station of the Kyushu Hydro-Electric Company equipped with Dengyosha machinery of ultra modern construction which stands comparison with products of topnotch makers of Europe and America

After the termination of the World War, however, the mental attitude of Japanese industrialists underwent a change; and foreign manufacturers were experiencing difficulties in making both ends meet, owing to post-war industrial conditions facing them at home, which compelled them to search for new fields for conquest in the foreign markets. Prior to the Great War, only one manufacturer each of Germany, Switzerland and Sweden respectively was active in the turbine business in this country. After the war not only the two latter countries swelled their number of machinery suppliers, but American and British makers appeared as newcomers in the business.

The list of suppliers now stood at 12, of which one was German, as before, two each from Switzerland, Sweden and England, and five from America. On top of this imposing array of foreign suppliers, four home manufacturing concerns were actively engaged in the contest, offering turbines which embodied features of merit peculiar to each concern. Thirty years of experience in maintaining hydro-electric plants had given public utility executives of this country mature knowledge and technique regarding turbines and equipments, and technical experts in the employ of hydro companies were in a very receptive mood for any new forms of propaganda, supplied by turbine suppliers during these days of keen international competition. The result was that all manner of turbines, from every famous machinery plant in the world, were purchased and installed in the hydro plants of the country, so that very soon Japan presented a regular international spectacle of hydro turbines. This development contributed much toward the phenomenal rise of Japan as a turbine manufacturing country during the following few years.



(18) **The exterior view of the power generating plant of the Tenryugawa Electric Power Company operated by a Dengyosha 22,000 H.P. hydro-turbine. (August, 1928) Head 260 ft. 22,000 H.P.**

XVII—Research Work by Japanese Turbine Makers, and Progress in Their Manufacturing Methods.

When given the real test in the power plants of this country, not all of these imported turbines, supposedly manufactured by the pick of the world's makers, demonstrated satisfactory results in point of efficiency as

Chart 2

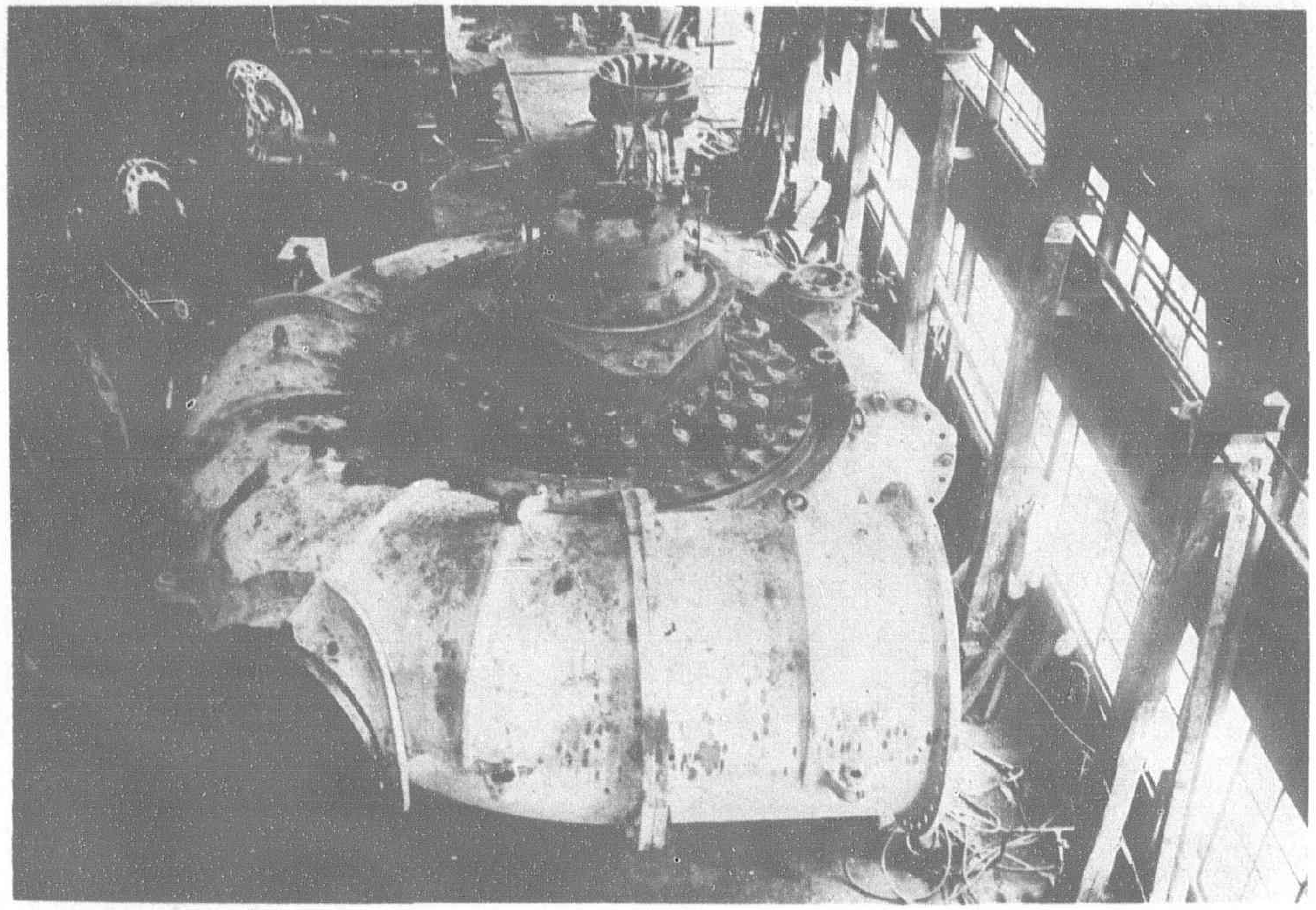
The Cost of Civil Works, Generator, Turbine and their Accessories, Compared with the Whole Plant Cost

Location (Prefecture	Head in feet	Discharge cu.ft. per min.	Horse-Power	Speed	Number of turbines *A	Number of turbines *B	Total capacity in horse-power	Total output in KVA.	Cost of whole plant (Yen)	Cost of civil works (Yen)	Cost of elect. mach'y & equip't (Yen)	Cost of turbine & equip't (Yen)	†Civil works per cent	†Elect. mach'y & equip't per cent	†Turbine mach'y & equip't per cent	Year comp'd
Toyama	85	1,700	3,400×4	360	4		13,600	2,800×4	3,305,780	2,535,452	570,328	200,000	76.7	17.3	6.0	1926
,,	90	250	2,000	514	1		2,000	1,500	661,333	519,968	71,365	70,000	78.6	10.8	10.6	1920
Hokkaido	420	650	4,600×4 7,500	300 600	4 1		25,900	3,125×4 6,250	2,262,815	1,537,705	519,618	205,492	68.0	23.0	9.0	1910 1914
,,	65	600	3,530	257	1		3,530	2,500	653,612	471,270	102,679	79,663	72.1	15.7	12.2	1917
,,	77.86	1,100	2,700×3	257	3		8,100	2,300×3	1,772,160	1,235,359	305,140	231,661	69.7	17.2	13.1	1921
,,	83.224	1,400	3,750×3	257	3		11,250	2,560×3	2,693,359	2,152,155	377,102	164,102	79.9	14.0	6.1	1926
Nagano	267.3	1,500	19,800×2	300/250	2		39,600	15,000×2	5,714,513	4,207,957	1,079,391	427,165	73.6	18.9	7.5	1924
,,	129	1,400	5,800×3	277	3		17,400	5,000×3	4,276,744	3,417,788	573,929	285,027	79.9	13.4	6.7	,,
Gifu	72.64	3,400	12,000×2	150	2		24,000	2,000×2	3,978,317	2,584,958	976,169	417,190	65.0	24.5	10.5	,,
Niigata	176	200	1,800 1,500 800	514 600 600	2	1	3,300	1,500 1,000	497,322	360,478	86,048	50,796	72.5	17.3	10.2	1915
,,	350	220	3,500×2	500	2	1	7,000	3,250×2	1,999,268	1,314,252	484,087	200,929	65.7	24.2	10.1	1920
,,	667.5	440	13,700×2	514	2	1	27,400	10,000×2	4,977,274	4,097,926	678,732	200,616	82.4	13.6	4.0	1926
Gifu	278	290	3,875×2	600	2		7,750	2,625×2	1,580,133	1,235,312	254,227	90,594	78.2	16.1	5.7	1920
,,	995.3	155	7,500×2	450	2		15,000	6,000×2	2,588,263	2,022,055	472,631	93,577	78.1	18.3	3.6	1925
,,	163.5	160	2,500	600	1		2,500	2,000	527,888	458,452	46,547	22,889	86.9	8.8	4.3	1927
Gunma	243.9	500	5,950×2	600	2		11,900	4,375×2	3,490,581	2,951,246	426,385	112,950	84.6	12.2	3.2	1926
,,	326	600	9,250×2	500	1		18,500	6,875×2	3,817,644	3,131,837	530,307	155,500	82.0	13.9	4.1	,,
,,	384	260	4,800×2	600	2		9,600	3,750×2	1,731,741	1,339,489	321,852	70,400	77.3	18.6	4.1	,,
Kanagawa	209	440	2,150×4	500	4		8,600	1,250×4	2,643,330	2,175,980	258,900	208,450	82.3	9.8	7.9	1910
,,	136	480	3,100×2	500	2		6,200	2,150×2	3,210,000	2,804,560	271,000	134,440	87.4	8.4	4.2	1914
Shizuoka	145.5	600	4,200×2	500	2	1	8,400	3,000×2	2,555,800	1,860,000	454,300	241,500	72.8	17.8	7.4	1925
Nagano	566 560 558	62 30 30	3,100 1,500 1,550	300 450 450	3		6,150	2,000 1,250 1,050	637,584	476,155	118,625	42,804	74.7	18.6	6.7	1906
,,	1,134	122	5,720×3	600	3	1	17,160	4,000×3	2,030,493	1,576,808	284,768	168,917	77.7	14.0	8.3	1927
Niigata	424	216	4,230×2	600	2		8,460	3,000×2	1,742,940	1,259,649	338,473	144,818	72.3	19.4	8.3	1919
Nagano	287	55	1,500	720	1		1,500	1,250	317,010	263,292	37,360	16,358	83.0	11.8	5.2	1925
,,	395	75	2,850	720	1		2,850	2,500	349,765	243,827	82,044	23,894	69.7	23.5	6.8	1928
,,	440	70	2,900	720	1		2,900	2,500	535,046	483,479	28,341	23,226	90.4	5.3	4.3	,,
,,	283	55	1,500	720	1		1,500	1,250	347,597	298,499	29,019	20,079	85.9	8.3	5.8	1923
,,	153	44	625	450	1		625	400	101,956	69,679	23,942	8,335	68.3	23.5	8.2	1910
,,	56	75	375	450	1		375	250	63,342	38,719	14,323	10,300	61.1	22.6	16.3	1918
,,	205	22	400	720	1		400	500	133,150	111,468	15,106	6,576	83.7	11.4	4.9	1926
Fukui	381.2	700	8,500×3	600	3	1	25,500	6,000×3	8,094,275	6,351,079	1,245,330	497,866	78.5	15.4	6.1	1923
,,	16.5	800	1,200	180	1		1,200	800	249,541	94,736	96,586	58,219	38.0	38.7	23.3	1927
Ishikawa	416	290	11,500	514	1	1	11,500	7,500	3,756,078	2,827,507	742,002	186,569	75.3	19.7	5.0	1926
Oita	210	300	6,000	500	1	1	6,000	5,000	1,884,169	1,122,035	554,235	207,899	59.6	29.4	11.0	1920
,,	287	310	4,250×2	600	2	1	8,500	3,750×2	2,266,824	1,387,302	674,843	204,679	61.2	29.8	9.0	1921
,,	128	650	4,000×2	375	2	1	8,000	3,000×2	2,008,710	1,248,362	616,536	143,812	62.1	30.7	7.2	1923
Kumamoto	309.8	170	5,000	500/600	1	1	5,000	3,750	1,585,506	1,064,254	465,472	55,780	67.1	29.4	3.5	1927
,,	120	490	5,625	300/360	1		5,625	4,000	1,004,786	728,589	233,697	42,500	72.5	23.3	4.2	1928
Oita	243	950	5,600×4	500	4	1	22,400	3,750×4	4,146,084	3,483,871	517,755	144,458	84.0	12.5	3.5	1913
Hokkaido	152	1,000	7,400×2	300	2		14,800	5,882×2	2,782,775	2,322,439	357,929	102,407	83.5	12.8	3.7	1927
,,	103	750	7,100	214	1		7,100	6,000	1,909,465	1,592,260	239,078	78,127	83.4	12.5	4.1	,,
,,	110	450	4,650	250	1		4,650	3,880	1,277,786	1,046,206	181,070	46,410	81.9	14.5	3.6	,,

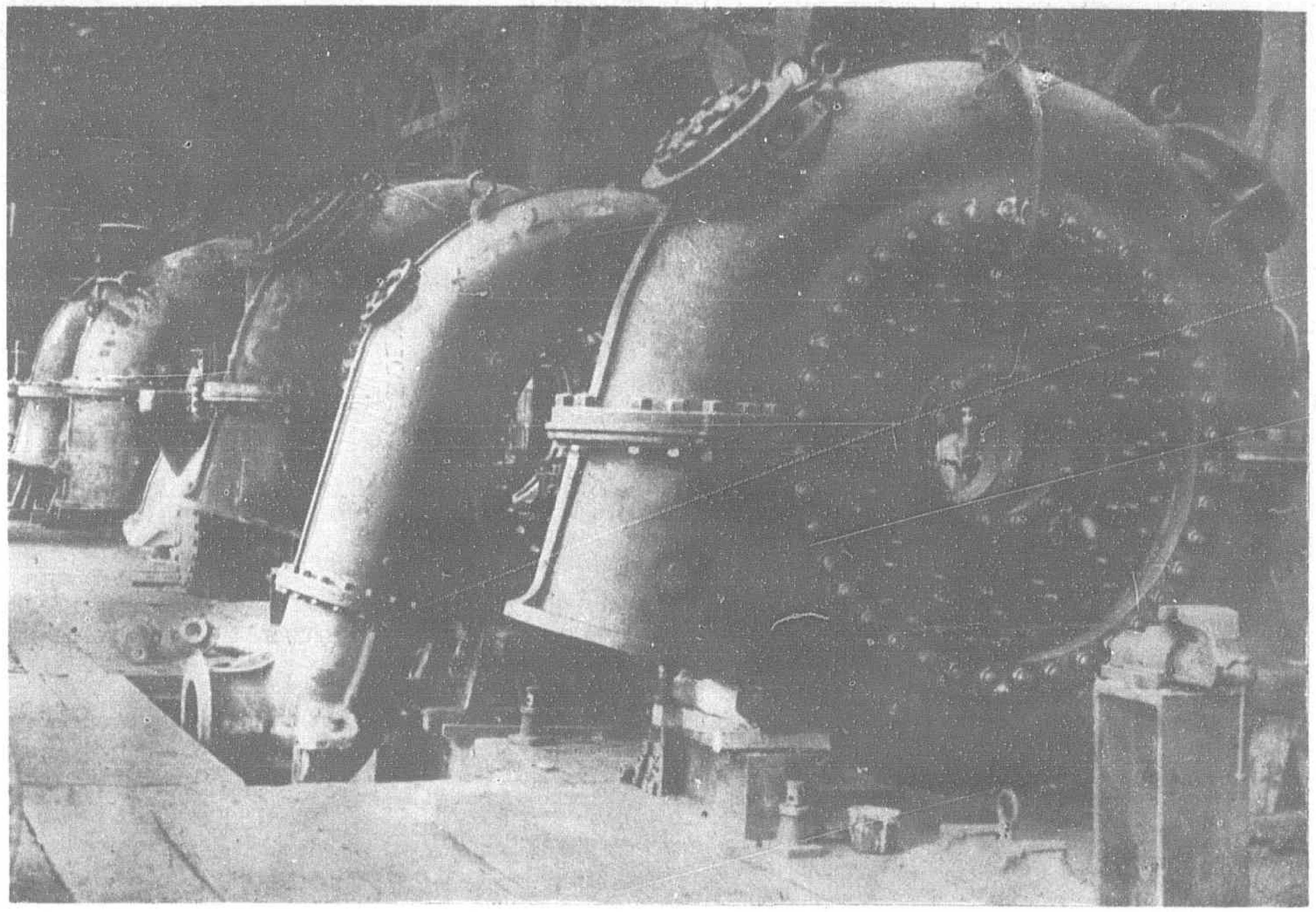
*Number of turbines, A—sets in regular use, B—spare sets.

†Cost of the whole plant 100 per cent.

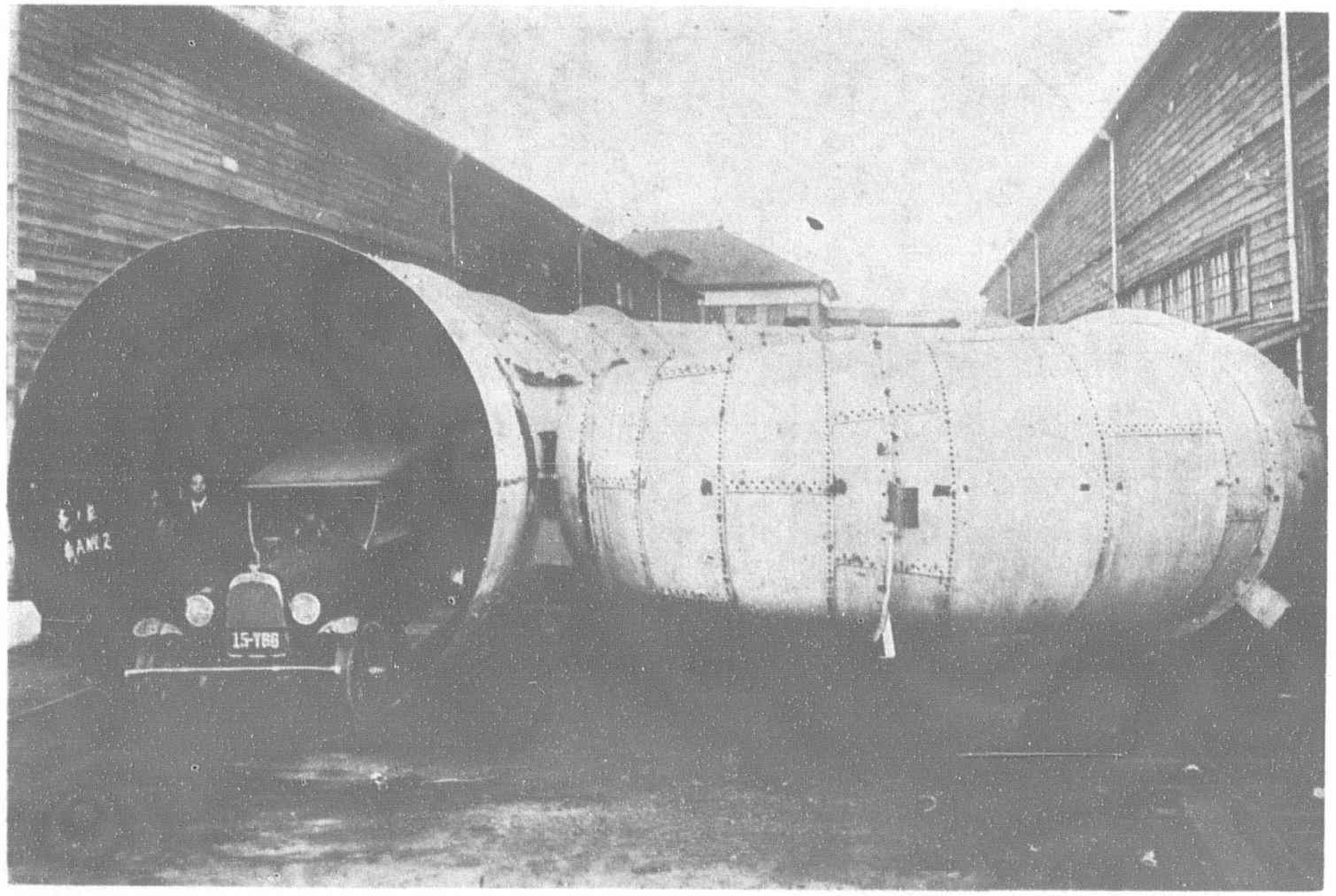
TYPICAL "DENGYOSHA" WATER TURBINE INSTALLATIONS



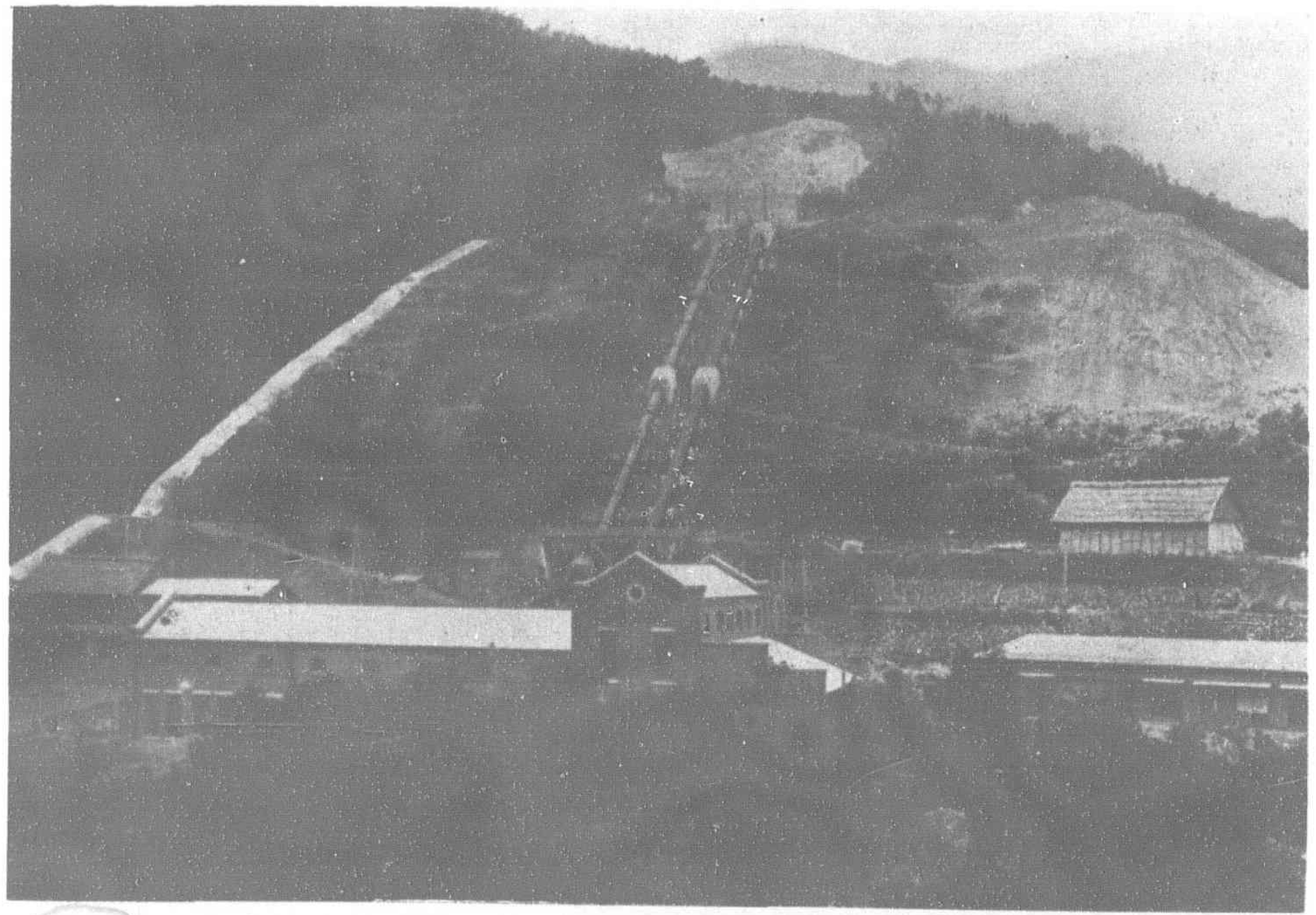
(17) 22,000 H.P. Dengyosha hydro turbine having a cast steel spiral casing, the largest so far manufactured in Japan, to be installed in the power plant of the Tenryugawa Electric Power Company



(10) A busy corner of the Dengyosha Prime Mover factory during the boom years of the World War. (about 1919)



(16) Turning out a large size spiral plate casing in the Dengyosha Works for the Wikawa Hydro-Electric Company. (March, 1929) Head 59 feet. 7,200 H.P. Japanese manufacturers have effectively checked further imports of these equipments.



(13) A complete view of the power station of the Ibigawa Electric Power Company which taps the Japan Alps water system and was the first power plant to supply current to Osaka: Equipped with Dengyosha Water Turbines

well as durability. Some of them fell far short of the promised perfect execution. Especially the majority of large output units proved to be mediocre much to the disgust of hydro industry executives. These occurrences enabled Japanese manufacturers to accumulate valuable technical data on turbine construction, and this has stood them in good stead to elevate them to an equal footing with the first class turbine makers of the world.

This result is not to be wondered at when one stops to consider that Japan, at that time, was turned into a veritable museum of the world's hydro machinery. This machinery was set into operation in all parts of the country, under varying conditions of water flow, which changes almost every hour. Japanese machinery makers were given the opportunity to study and work out proper remedies for the ever increasing cases of trouble developed by these units. Such experience was accountable for a rich store of valuable knowledge, which could be obtained only through personal observation of turbine construction being accumulated, and which often led up to an important discovery effecting successful turbine building. The application of these discoveries in the manufacture of their sets has enabled them to turn out turbines which are replete with many new and valuable features of their own, forming a class by themselves, distinct and apart from foreign makes which often develop weaknesses peculiar to each country, because the manufacturers in one country are prone to think so highly of their own products that they never think of studying the products of their rivals in other countries in order to improve their own.

On the other hand, hydro executives are now better equipped to pass sensible judgment on the merits and demerits of the products offered for their inspection. They now strive to gather in their plants the best in machinery and equipment. Manufacturers vie with each other in offering the best product their manufacturing and technical skill can produce. Nevertheless, as capitalists are beginning to lay increasing stress on the price consideration for their requisitions, and as they take advantage of the cut-throat competition among suppliers, the margin of profit for manufacturers is being reduced almost to nothing, tending to make their earning capacity untenable. Japanese manufacturers are required by the expert engineers of the hydro company to go to great pains to construct a turbine based on the very best construction plans, embodying several new features, while its directors demand that such a miracle of creation should be sold for a mere song. These two situations do not go together very well and this treatment by hydro corporations is proving a thorn in the flesh of turbine manufacturers these days.

(Continued in June issue)

Development of Water Tube Boilers in Japan

(Continued from page 230).

consumption rate in this country is concerned, but even this 2.5 lbs. is considerably higher than the corresponding figure in any other country. This is mainly due to low calorific value of fuel coal used and that majority of our steam plants are used as stand-by stations to hydro-electric plants, thereby making their use factor and annual load factor extremely low, and finally to the fact that great many older power stations of small capacity are still in operation.

It is, therefore, of paramount importance for us to choose the most adaptable stoker to meet this peculiar condition existing in this country. Table VII gives the varieties of stokers now used in principal power stations and relative size of heating surface of boilers fitted with each variety.

As is shown in the Table, heating surface of boilers using chain grate stokers, takes up 70 per cent. of the total heating surface of all boilers installed in power stations for general service. In 1924, Toho Electric Power Co. made a comparative test of "Lopulco" system of pulverized firing against a compartment type of chain grate stoker in their Najima Station. The latter was found to be much more favorably adapted to the load condition of that particular station and to the quality of fuel coal used. Thereupon, the chain grate stokers of compartment type were adopted in boilers which were added at the plant just mentioned, and also at this Company's Nagoya Plant, which was completed in the following year. Since then, this type of stoker gained its popularity amongst medium and large sized stations, and the heating surface of boilers fitted with this compartment type grew up, within a few years, to cover 16 per cent. of the total.

TABLE VII.—TYPE OF STOKERS USED IN POWER PLANTS.

Type of Stoker	Boilers for general service & Electric Railway Plants		Boilers for Industrial Plants	
	Per Cent of Heating Surface	Per Cent of No.	Per Cent of Heating Surface	Per Cent of No.
Chain grate	53.9	61.1	60.1	66.5
Compartment type chain grate	16.2	9.8	—	—
Travelling grate..	8.9	12.5	6.8	7.6
Riley Underfeed	7.7	4.6	4.2	3.4
Westinghouse Underfeed ..	4.8	4.3	—	—
Taylor Underfeed	2.3	2.1	—	—
Jones Underfeed	0.4	0.6	—	—
Murphy Overfeed	0.1	0.2	—	—
Pulverized Coal Firing ..	4.5	2.8	1.2	1.1
Hand Stoking	1.2	2.0	7.0	10.4
Waste heat of Cement Kiln ..	—	—	20.7	11.0
Total	100.0	100.0	100.0	100.0

Remarks: Boilers in this table do not include those for plants under 1,000 K.W. capacity.

Under-feed stokers are only used in large power stations, where sudden fluctuation of load is experienced, boilers fitted with this type of stokers taking up 15 per cent. of the total heating surface. Majority of under-feed stokers so fitted in this country is of Riley type, which gives an agitating motion on grate surface.

As to the pulverized firing, only 24 boilers with aggregate heating surface of 186,816 sq. ft. are equipped with this device at present. This method of firing was first introduced to Japan, in May, 1921, when Hikoshima Plant of Nitto Ice Manufacturing Co., Ltd. started its operation with "Hirotani" aero type pulverizer in conjunction with two Babcock & Wilcox boilers, which were supplying steam to 1,000 K.W. Ljungstroem turbine. In 1922, Nippon Electric Power Co. adopted at its Amagasaki Power Station "Lopulco" system of pulverizing to supply four boilers out of eight installed there, and successively in 1927, another four boilers, out of eight newly added in the same plant, were arranged for pulverized firing, using "Lopulco" type pulverisers. Favorable results gained from these equipments are now endorsing the advantage of using pulverized firing.

With the recent introduction of tube wall system fitted inside the combustion chamber, as an effective means of absorbing radiant heat thereby lowering the temperature of combustion gas, so as to prevent the fusing of ash, pulverized firing has gained remarkable popularity. In steam power station of 50,000 K.W. capacity, belonging to the Railway Department, now under construction, four Sterling boilers of three drum type, each having heating surface of 13,450 sq. ft. are to be fitted with Fuller system of pulverized firing. And there are several other stations now being projected for the adoption of this system of firing.

Utilization of waste heat from rotary kilns at cement factories is now drawing much attention of steam engineers, and, the electrical energy amounting to 56,800 K.W. is being generated by means of this waste heat; the boilers employed for this purpose numbering to 49, with an aggregate heating surface of 376,291 sq. ft. The majority of these boilers is of Edgemoore type, representing 26 in number and 217,929 sq. ft. of heating surface; this being followed by Babcock & Wilcox boilers.

Besides these boilers used in power stations, there are a little over 190 water tube boilers employed in private factories and mines. Their types are varied with working pressures ranging from 180 to 250 lbs. per sq. inch. Although the tendency of increasing demand is evident, there is nothing special to be mentioned on their development.

(Continued in June issue.)

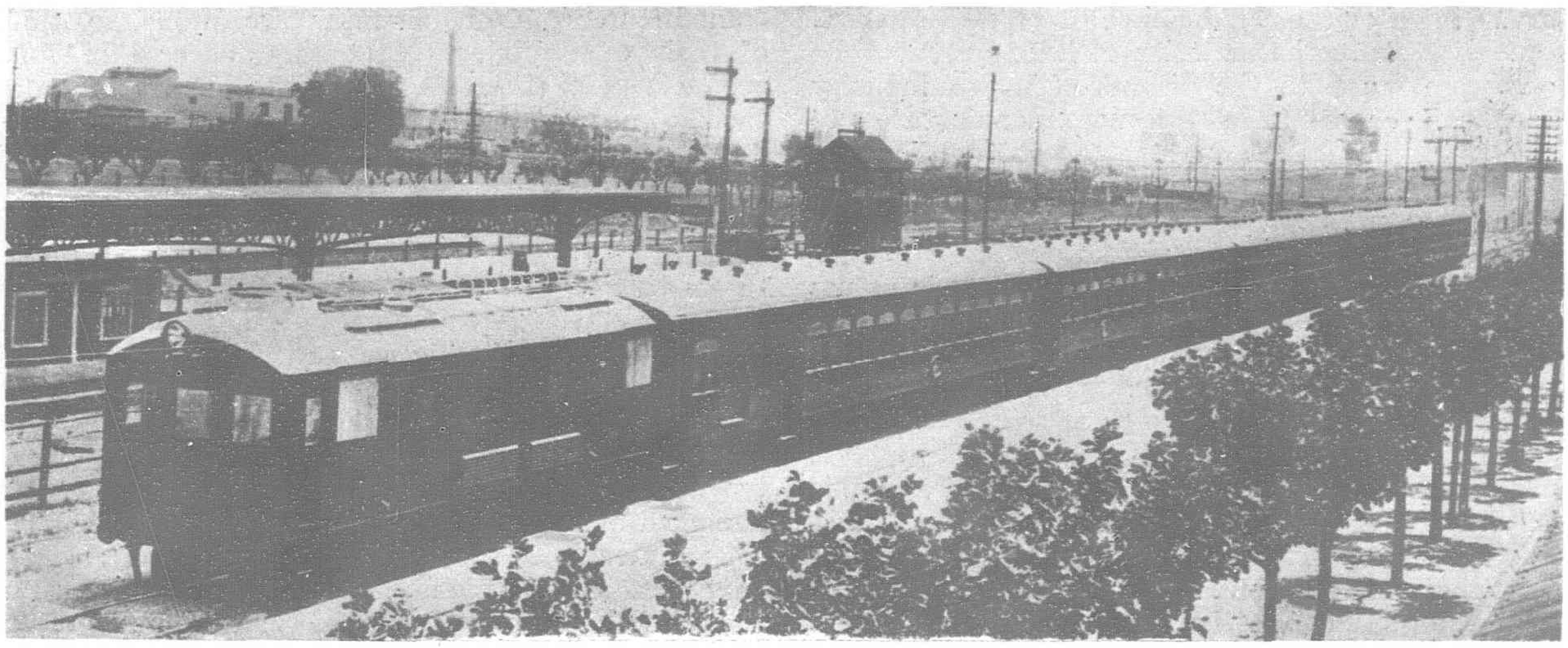


Fig. 1, 2, 3.—Diesel-electric train unit of the Buenos Aires Great Southern Railway, consisting of a 1,200 BHP. "travelling power station" with Sulzer Diesel-Electric sets and five electrically driven rail cars.

Diesel Traction on the Buenos Aires Great Southern Railway

In nearly all large cities the steady increase in suburban traffic on the railways is continually leading to special problems. Steam traction, as is well known, has certain drawbacks; it cannot handle a large number of trains at frequent periods of rush traffic, the acceleration is low, the steam locomotives are inefficiently utilized and contaminate the atmosphere with soot and smoke. The Buenos Aires Great Southern Railway Co. consequently decided to change over to a more up-to-date method of traction. After investigating the merits and drawbacks of various systems, Diesel Electric traction was chosen. It was found that considerable savings could be effected by this system of traction rather than by completely electrifying the lines. Conversion of part of the service to Diesel drive was first of all decided on, and a number of Diesel locomotives were ordered. The requirements of suburban traffic led to the following conditions being laid down for the Diesel-engined vehicles. The mean speed should amount to 28 miles per hour on lines 20 to 30 miles long with stops at stations 1¼ to 1¾ miles apart, whilst the maximum speed was fixed at 45 miles per hour. These conditions are the same as for suburban electrification.

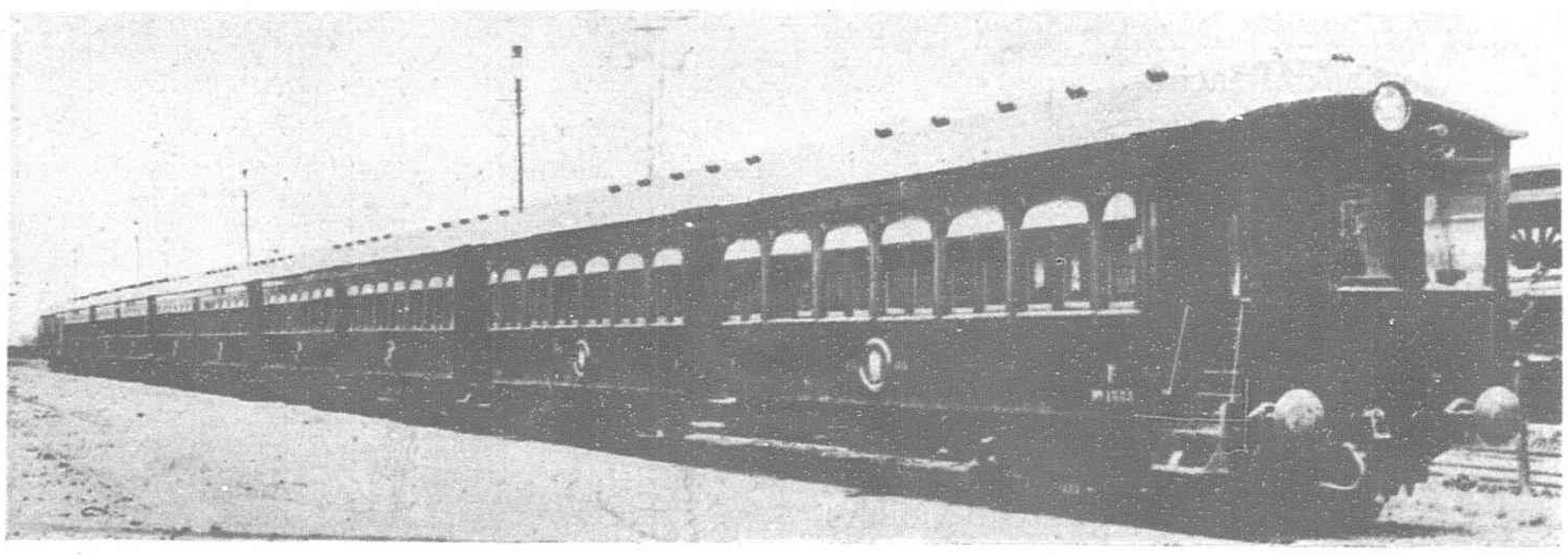


Fig. 1, 2, 3.—Diesel-electric train unit of the Buenos Aires Great Southern Railway, consisting of a 1,200-BHP. "travelling power station" with Sulzer Diesel-Electric sets and five electrically driven rail cars.

Two of the locomotives used are provided with two eight-cylinder Sulzer-Diesel engines each totalling 1,200 B.H.P. The engines are coupled to D.C. dynamos, which supply current to the driving motors distributed among all the vehicles constituting the train, the locomotive itself being equipped with two 136-B.H.P. motors which are mounted in the approved tram type suspension and drive the two outer axles of the four forming the rigid wheel base. The two inner pairs of wheels are simply carrying axles; the two end axles are mounted in Bissel trucks. The carriages composing the train have each four axles, two of which, one in each bogie, are driven by tram-type 100-B.H.P. motors. In this manner trains of electric rail-cars, with five carriages, are built up, the electric energy being supplied by the Diesel-electric locomotive which has been termed a "travelling power station" (figs. 1 to 3.). Each of the Diesel-electric sets on the locomotive supplies energy to one motor on the locomotive and to one motor on each of the carriages. In this manner it is possible, if desirable, for the train to run on half the output of the locomotive. Such a composition evidently possesses great adhesion, 12 of the 26 axles of the train being driven. This is of great value, particularly in the suburban traffic for which these trains are intended, since the high acceleration required for such traffic can thus be obtained. In order to allow the train to be run in either direction without having to change the locomotive from one end to the other, the fifth carriage is fitted with a driver's cab from which the Diesel engines in the locomotive can be controlled.

In order to be able to run still larger trains, two compositions of the type described above will be coupled together when required, thus giving a train of ten carriages with a locomotive at each end. The Diesel engines in the locomotive at the rear of the train are controlled electrically from the locomotive at the front.

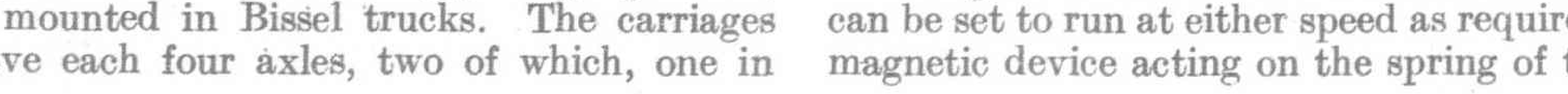


Fig. 1, 2, 3.—Diesel-electric train unit of the Buenos Aires Great Southern Railway, consisting of a 1,200-BHP. "travelling power station" with Sulzer Diesel-Electric sets and five electrically driven rail cars.

The locomotives themselves (figs. 4 and 6) are noteworthy for a number of constructional details. As in all Sulzer Diesel locomotives, the output of the Diesel engines is governed at constant speed. The governor controls the admisssion of fuel to the cylinders in such a way that the quantity of fuel introduced corresponds to the output required. Regulating the supply of electric energy to the power and speed required is effected by a controller by varying the exciting current; this system entails practically no loss of energy. In order to obtain a still wider range of output, the Diesel engines are designed to run at two different constant speeds. The engines can be set to run at either speed as required, by means of an electro-magnetic device acting on the spring of the governor and operated from the driver's stand.

The Diesel engines are started electrically, the D.C. dynamo coupled to the engine being then run as a

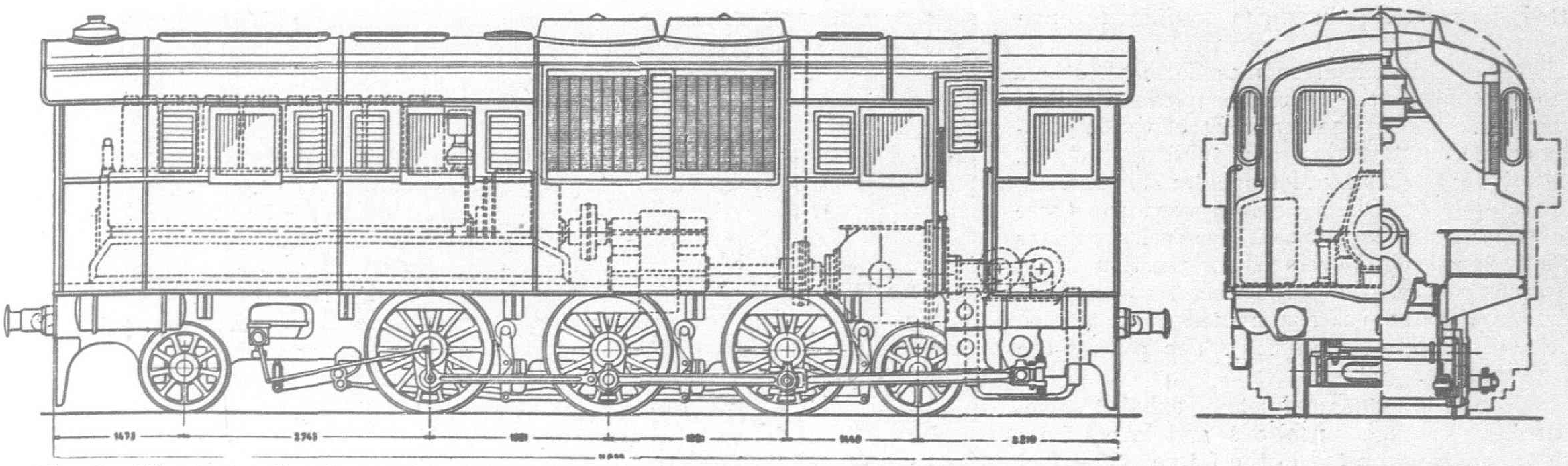


Fig. 9.—Diesel shunting locomotive of the Buenos Aires Great Souhern Railway with high-speed 600-BHP. Sulzer Diesel Engine and Vickers oil-operated hydraulic transmission.

motor, special series windings being supplied with current from a battery of accumulators The engines are stopped by an electro-magnetic device which causes the valves of the fuel pump to be raised.

Starting and stopping can be effected from the driver's cab by electric switches. In this manner the Diesel engines can easily be stopped by the driver during short stops at stations and also when the train is running downhill or slowing down, and be just as easily started again as soon as power is required. The saving in fuel thus effected is considerable. All auxiliary services, such as the fans of the air coolers for the cooling-water, the circulating pumps for water and oil, and the air compressor for the brakes, are driven electrically. The coolers are fitted on the sides of the locomotive. The fans for the coolers are

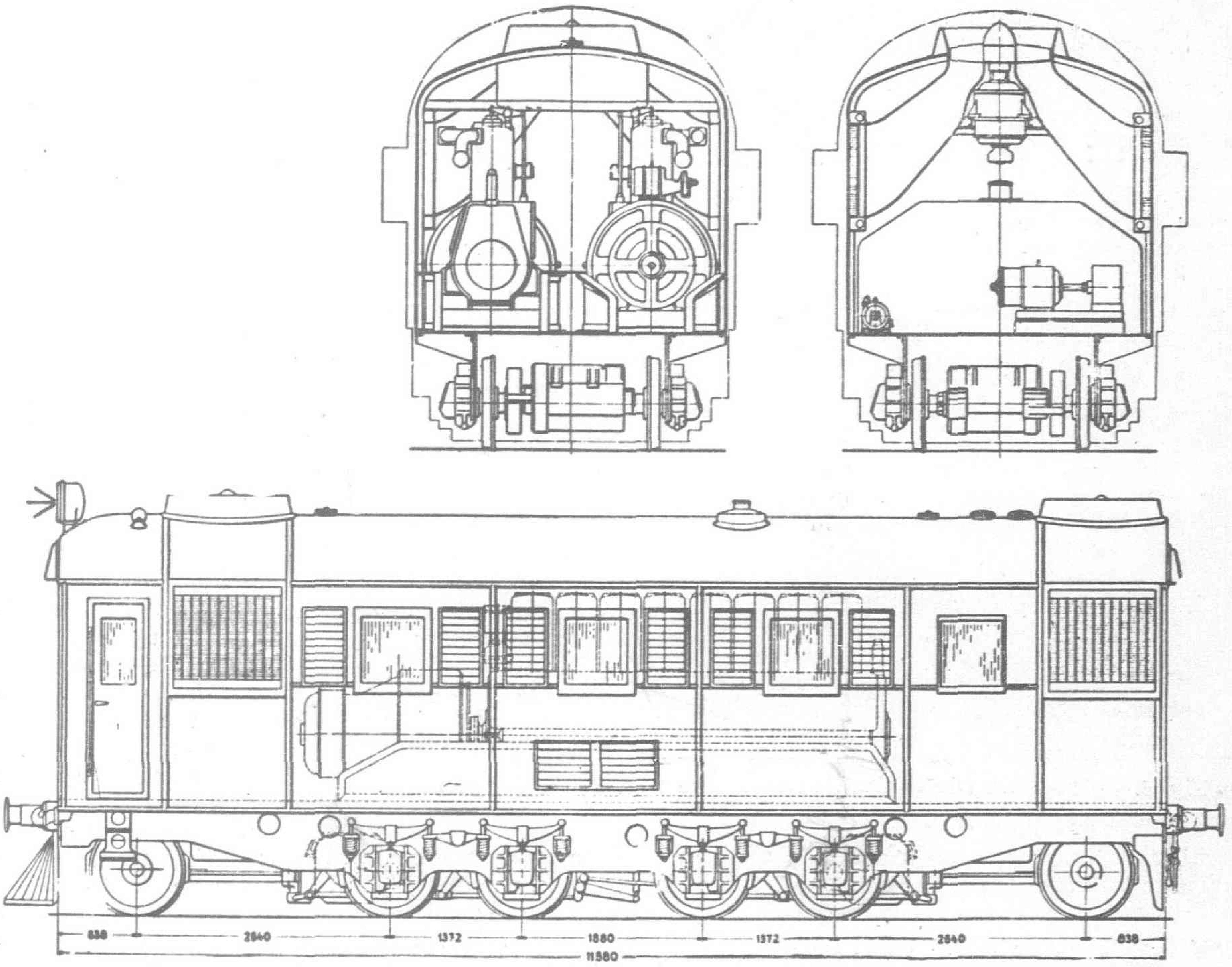


Fig. 6.—Diesel-Electric Locomotive ("travelling power station") with two high-speed 600-BHP. Sulzer Diesel Engines

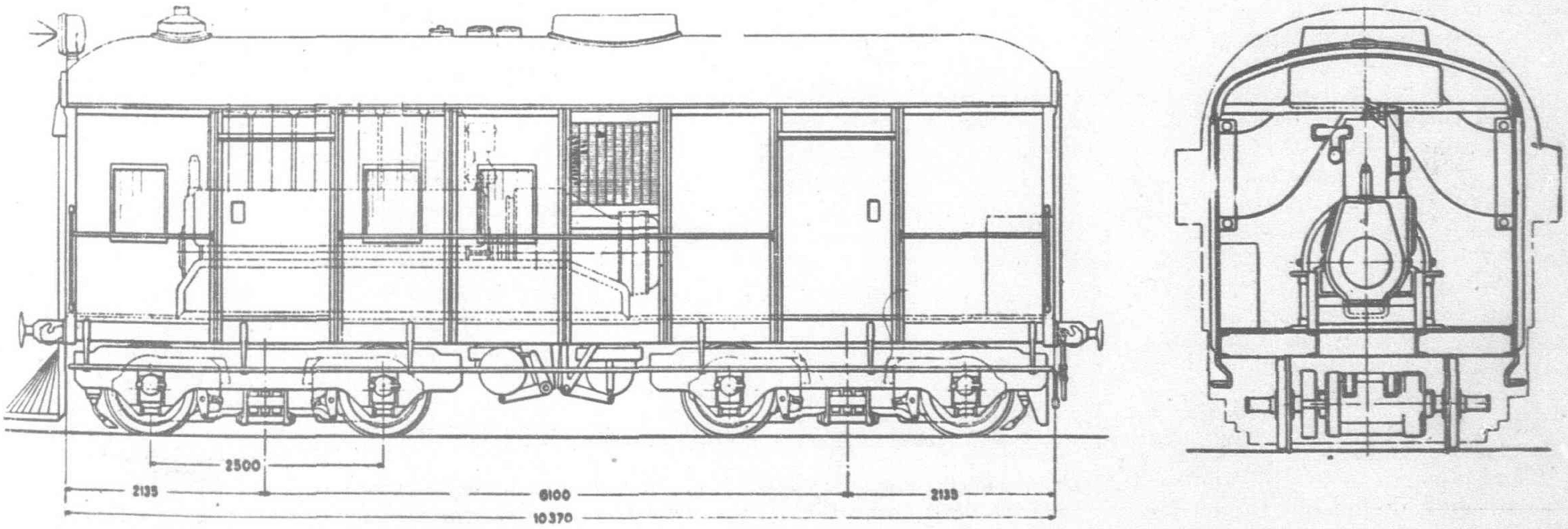


Fig. 11.—Diesel-Electric Locomotive with 420-BHP. Sulzer Diesel Engine, for hauling light trains of the Buenos Aires Great Southern Railway

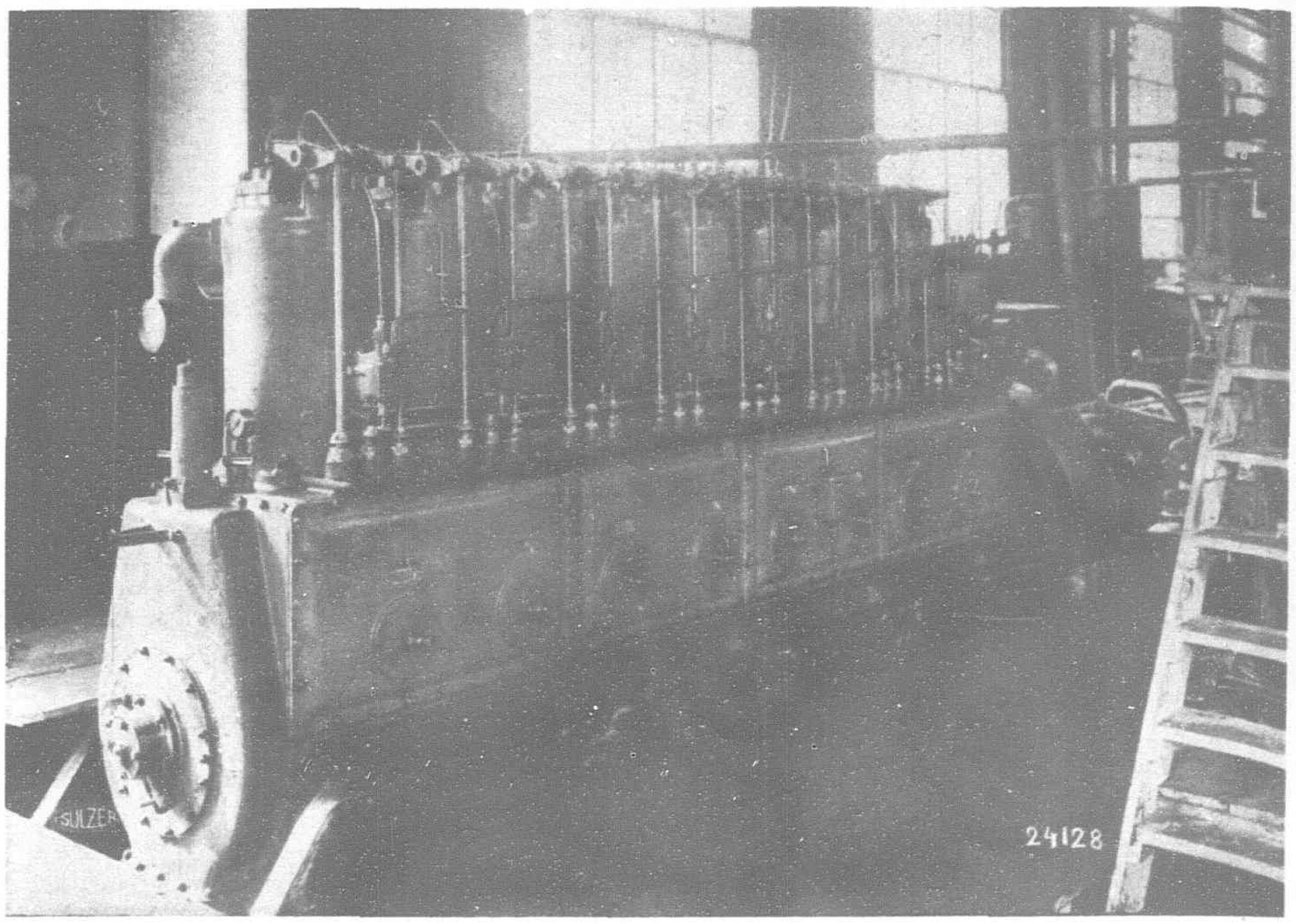


Fig. 10.—Diesel Engine of the 600-BHP. shunting locomotive of the Buenos Aires Great Southern Railway on the testbed in the Sulzer Works at Winterthur (Switzerland)

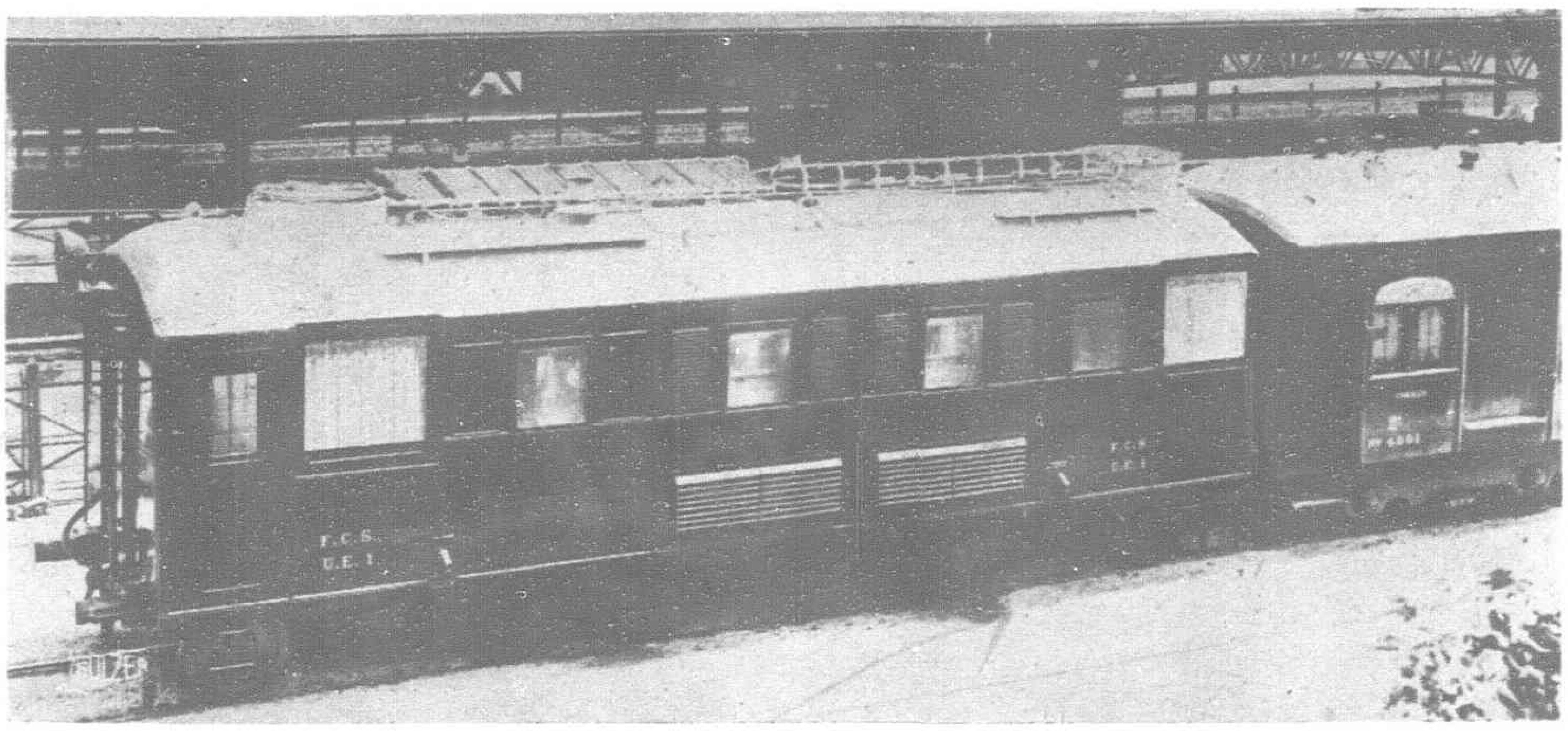


Fig. 4.—1,200-BHP. Diesel-Electric Locomotive with Sulzer Diesel Engines.

fitted horizontally in ducts leading through the roof.

With their Diesel engines Sulzer Brothers also supplied the direct-coupled Oerlikon dynamos. The mechanical part of the locomotives was made by Armstrong, Whitworth & Co., the driving motors by Metropolitan-Vickers.

The Sulzer Diesel engines used for these locomotives are high-speed four-cycles engines of a type specially developed for traction work. In order to keep down the weight as much as possible, the frame is constructed of cast steel, with special openings (fig. 7). The pistons are of aluminium.

Each cylinder has an inlet and exhaust valve, controlled through push-rods and levers from the camshaft supported in the frame. The fuel pumps are arranged between these push-rods and driven from the same camshaft. Each cylinder has a separate fuel pump which delivers a measured quantity of fuel at the moment of ignition. Fuel is injected and atomized without the help of air; the engine has therefore no air compressor. At the required moment, fuel is injected into a pre-combustion chamber situated in the upper part of the cylinder, where part of it burns. The greater part, however, reaches the distributing nozzle which lies between the pre-combustion chamber and the actual combustion space in the cylinder, and is forced through the holes in the nozzle in consequence of the rise in pressure in the pre-combustion chamber, arriving in the combustion space in a finely atomized state and then burning up completely. In comparison with direct injection, this system has the advantage of requiring a lower injection pressure. It is also possible to use an injection nozzle with one large hole about one mm in diameter and a distributing nozzle also with comparatively large holes; this has the advantage of ensuring more certain function of the nozzles. as there is less risk of the holes becoming coked up or choked.

The carriages for the train, designed as electric rail cars, are remarkable for their size, 85 feet long. They are provided with special coupling bars, fitted with shock absorbers and attached to the car frame near the pivots of the bogies. In this manner the train can take the curves easily, in spite of the great length of the carriages. A five-coach train has seats for 554 persons and consists of three first-class and two second-class coaches, one of the latter being provided with luggage and postal compartments. The carriages were built by the Buenos Aires Great Southern Railway Company in its own workshops.

The Buenos Aires Great Southern Railway has also had a shunting locomotive built (fig. 9); it is of the 2-6-2 type, with hydraulic transmission of power to the axles, and is equipped with an eight-cylinder Sulzer Diesel engine of the same design as those used for the locomotives described above. The engine is direct coupled to an Oerlikon 60-K.W. dynamo, which serves to start the engine and then supplies current for the auxiliary services (fans, circulating pumps, air compressor, etc.). The Diesel engine works through toothed gearing on a Vickers oil-operated power-transmission, which drives the three driving axles of the locomotive through coupling rods. At front and rear are carrying axles of the Adams type. For cooling the oil of the hydraulic transmission gear, the same type of cooler with fan is adopted as for the cooling water. The two cooling plants are arranged alongside each other. As this locomotive is intended for shunting use, a driver's cab is provided at one end only. The casing enclosing

(Continued on page 245).

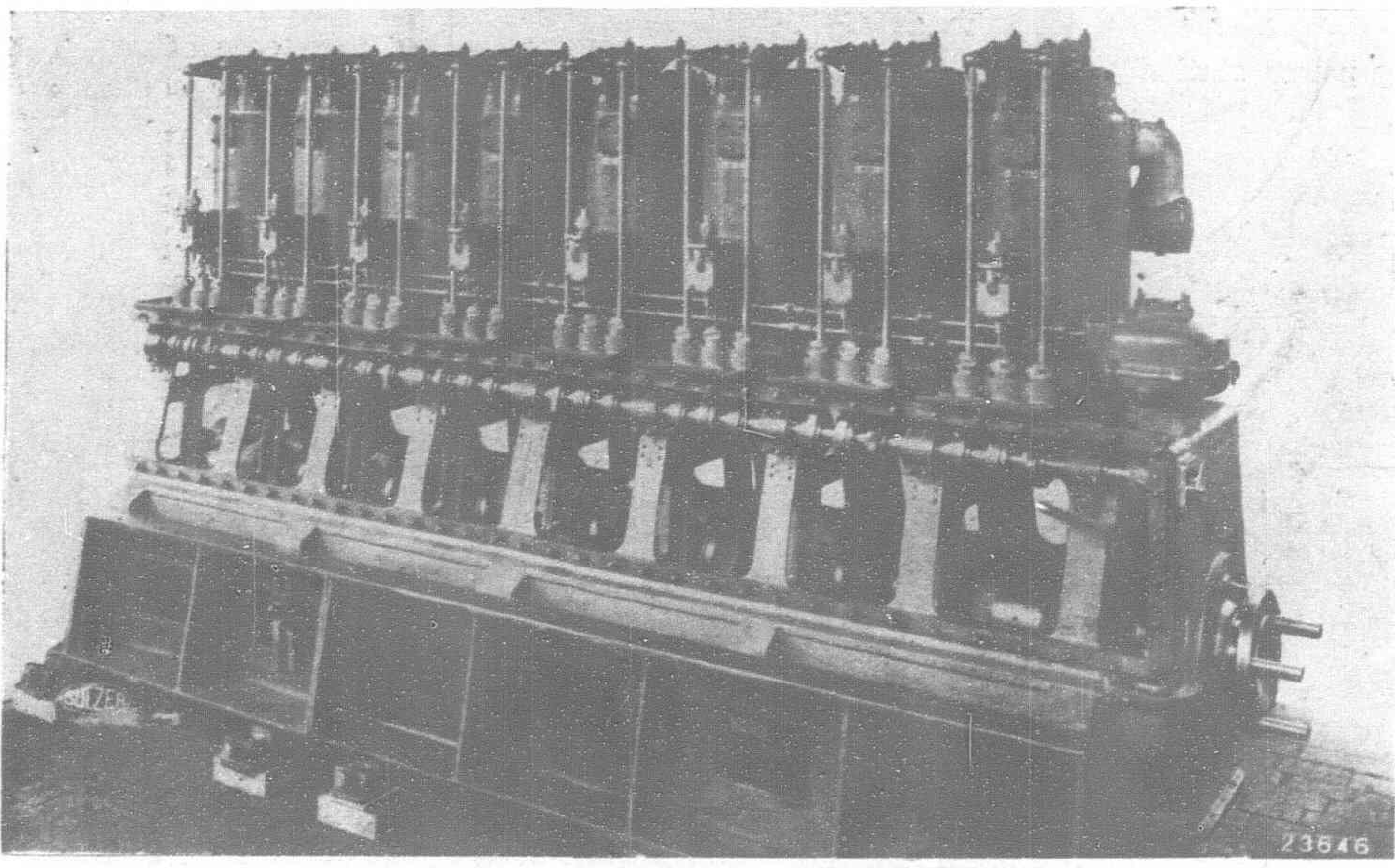


Fig. 7.—Sulzer Diesel Engine for the "travelling power station" locomotives of the Buenos Aires Great Southern Railway.

THE "TATSUTA MARU"

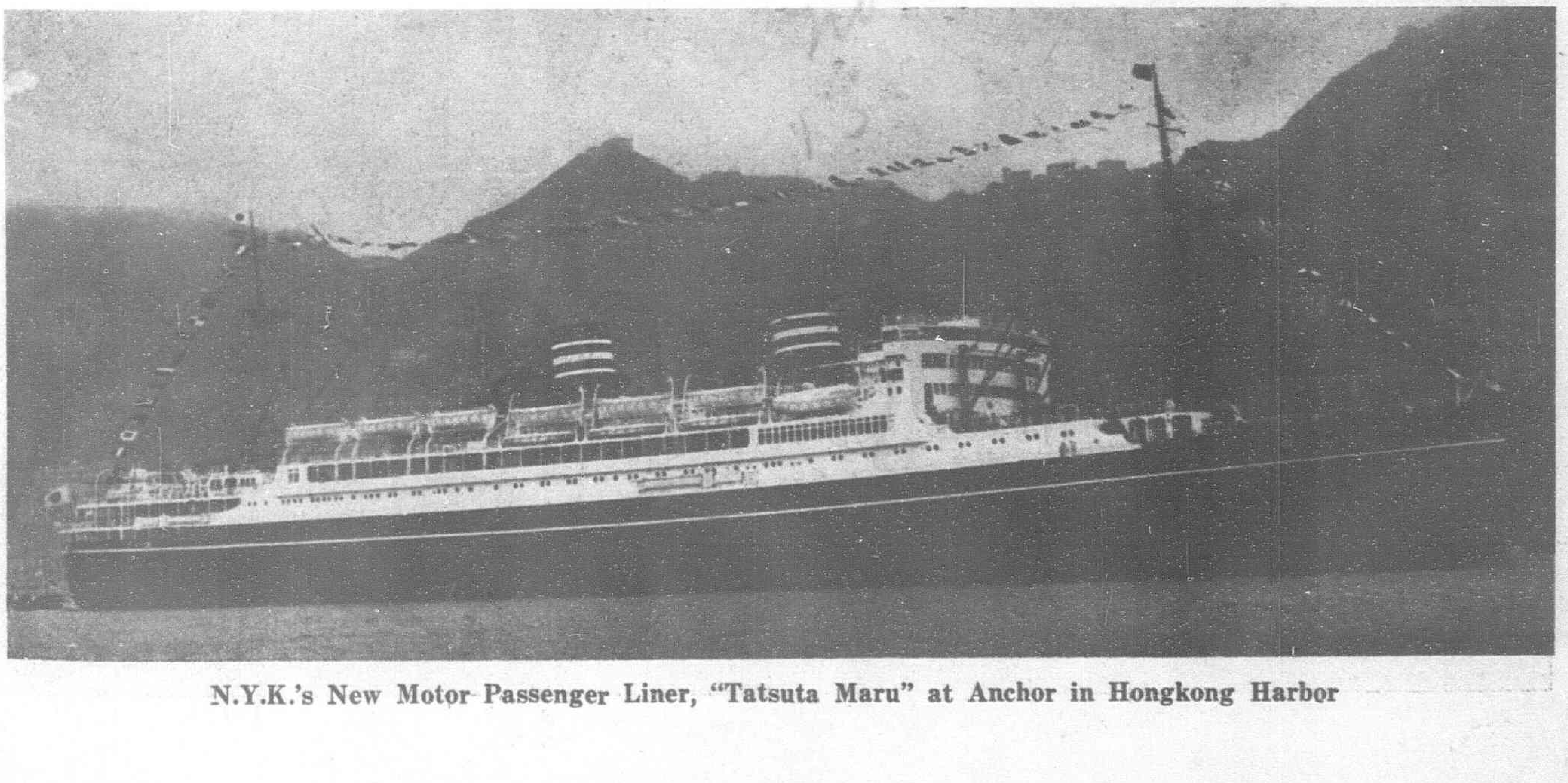
Last of the Trio of De Luxe Motor Passenger Vessels Built for the N.Y.K.'s Trans-Pacific Service

THE entrance into the Japanese shipping service of the *Tatsuta Maru*, last of the trio of Japanese-built motorships, marks a definite and considerable accomplishment in Japanese shipbuilding in the opinion of Mr. Hyo Hamada, chairman of the board of directors of the Mitsubishi Shipbuilding and Engineering Company, Limited, constructors of both the *Asama Maru* and her sister ship. In size and design the *Asama* and *Tatsuta* are identical and the *Chichibu Maru* differs by only a couple of extra feet in the beam ; yet one important point marks the last of these three craft to enter the N.Y.K's San Francisco-Orient service ; the mighty Diesel engines which drive the craft back and forth across the Pacific were constructed entirely in Japan.

The use of Diesel engines for large passenger craft was developed and perfected almost entirely by Japanese marine engineers, Mr. Hamada pointed out in a recent statement in *The Japan Advertiser*. When that type of power plant first began to be used at sea the experts of other nations were convinced that it would never prove practical for the larger passenger liners. The Diesels produced too much vibration, they were convinced, which for a liner de luxe would be too great a disadvantage to be offset by what was gained in space and freedom from smoke.

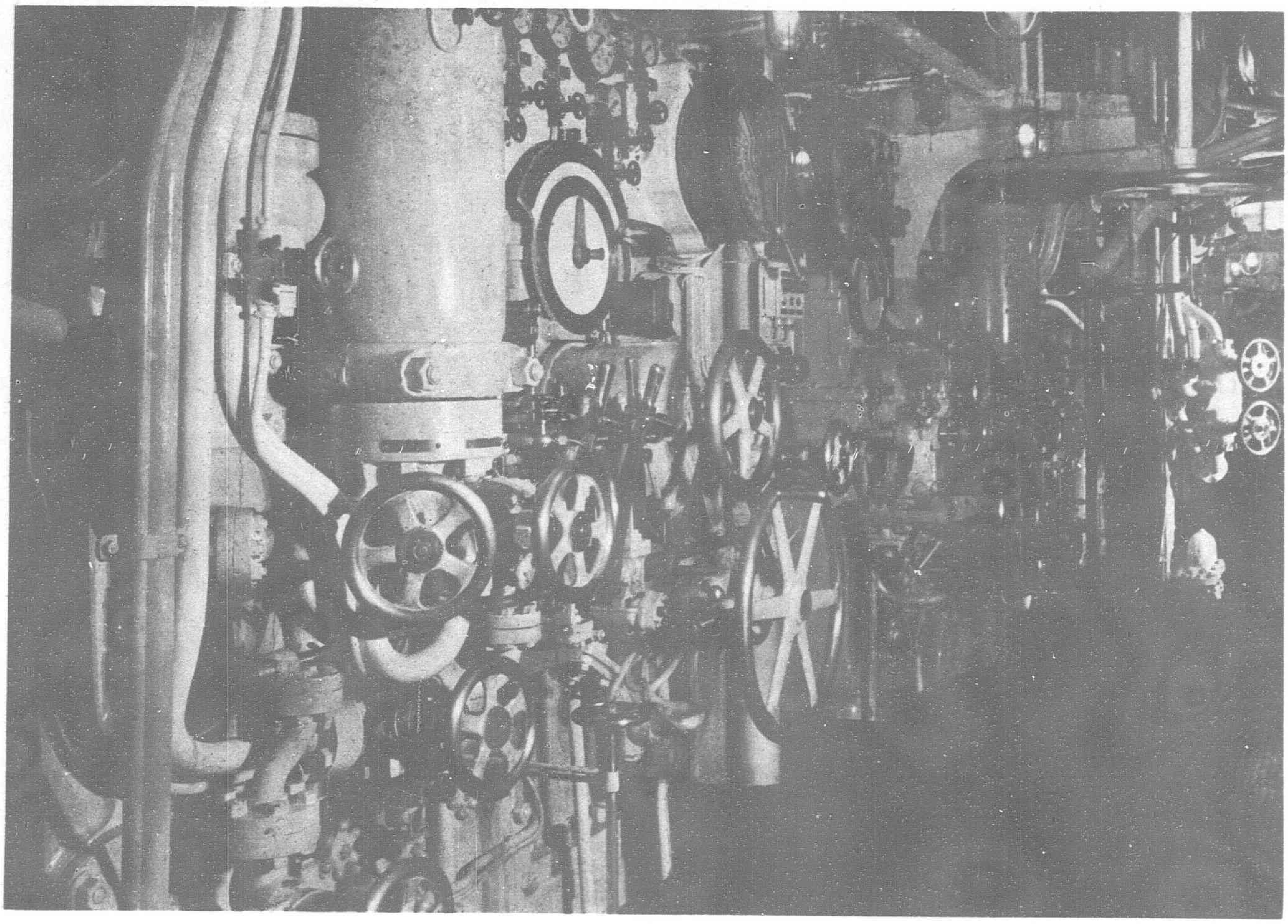
Japanese shipbuilders, however, and notably the Mitsubishi Company, tried out the Diesel over a number of years and were convinced that the vibration resulting from them was not nearly as great as had been feared, so when it was decided to engine the three new N. Y. K. craft with Diesels the result was awaited with interest. The *Asama*, first of the trio to go into service, went beyond their expectations. Vibration was reduced to a point noticably below that found in steam-driven vessels, a feature particularly apparent to the passenger when he sits down to write a letter with pen or pencil.

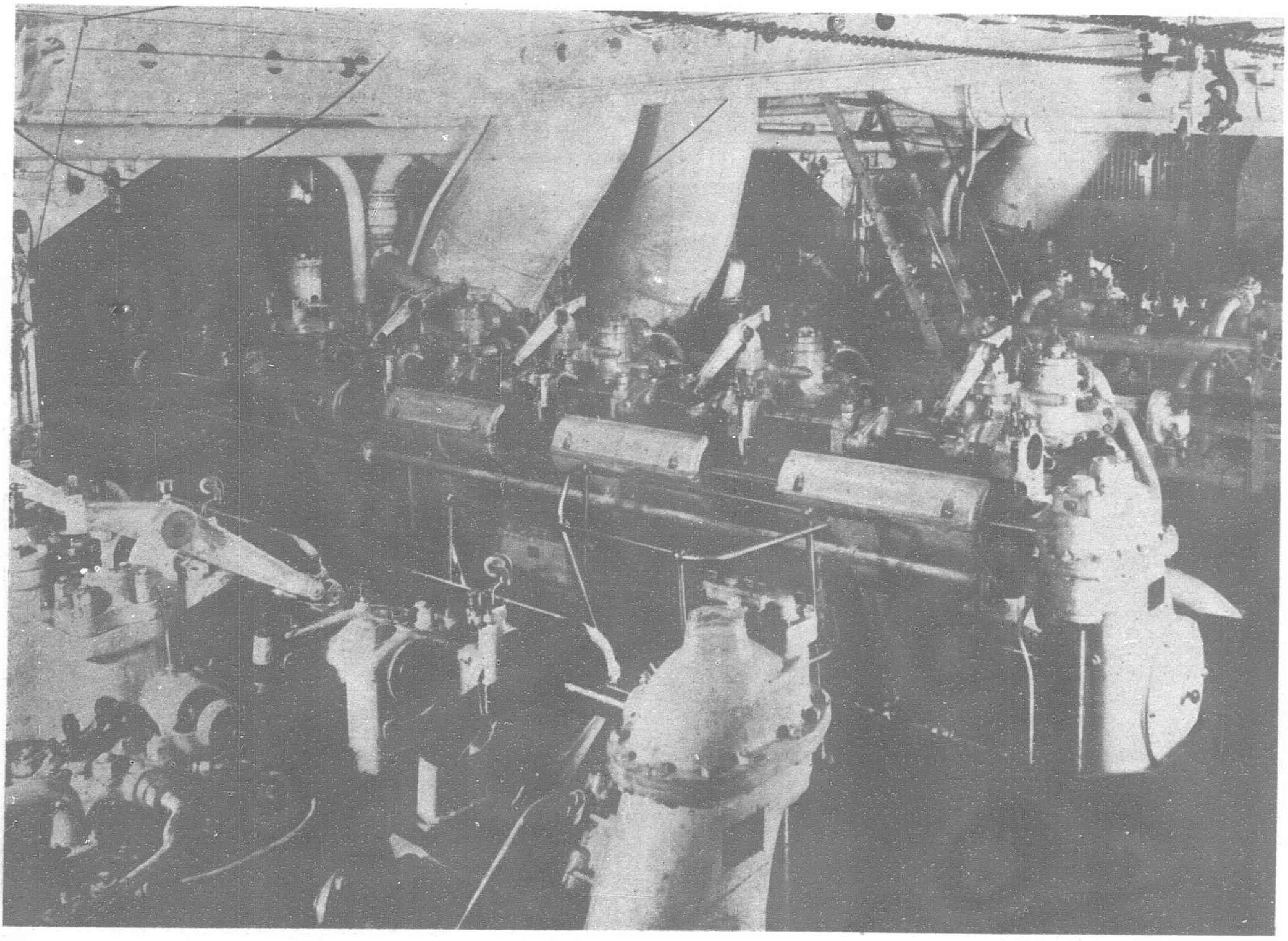
The *Tatsuta* is powered with 16,000 brake horsepower Mitsubishi-Sulzer single-acting, two-cycle marine Diesel engines. All its parts were made and assembled in the shops of the Mitsubishi Company, which holds manufacturing rights for Japan from the Sulzer interests. That this home-made plant compares favorably with those of the two sister ships, which were manufactured abroad,

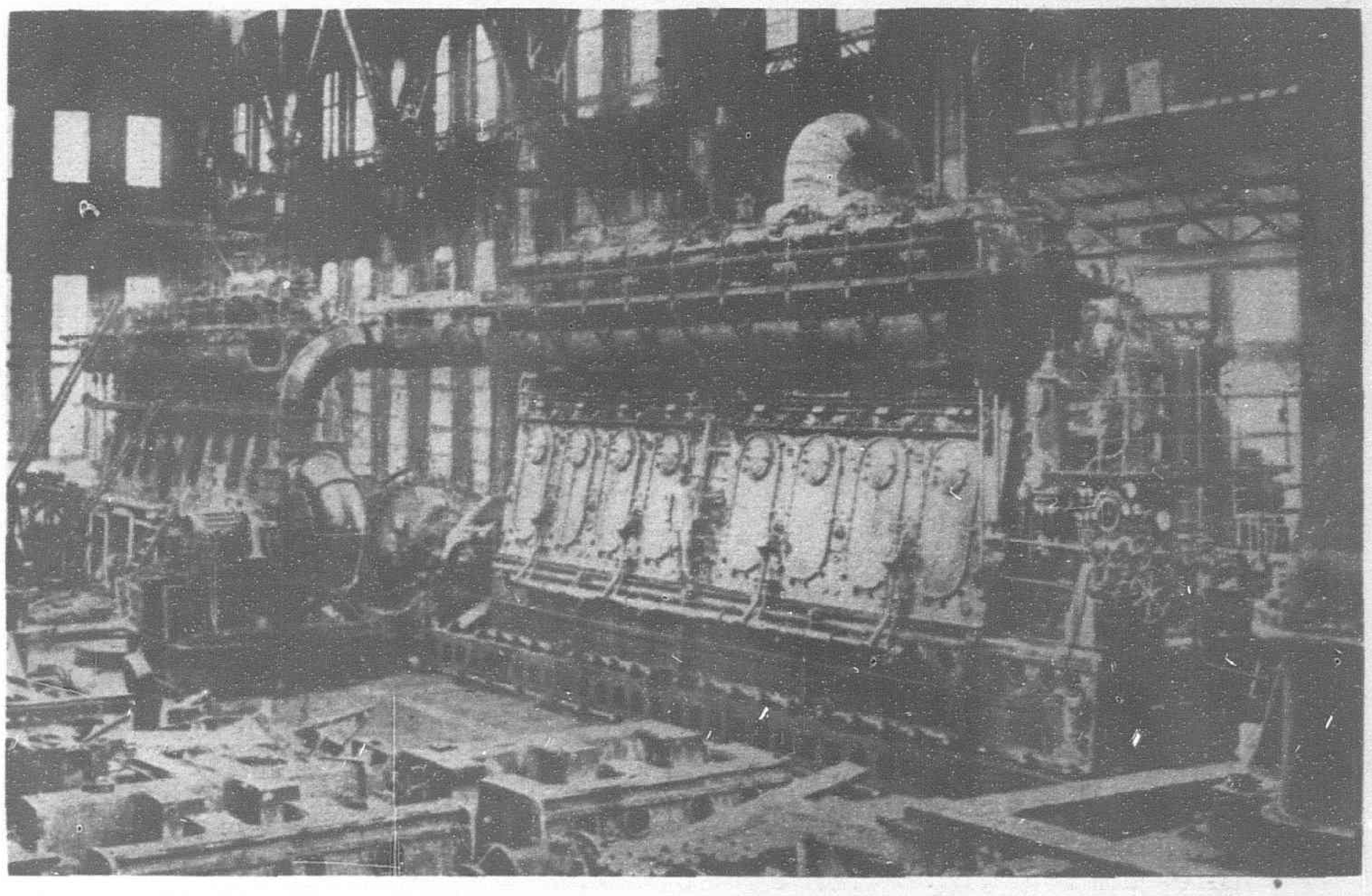


N.Y.K.'s New Motor Passenger Liner, "Tatsuta Maru" at Anchor in Hongkong Harbor

ENGINE ROOM OF THE "TATSUTA MARU"







Two of the Four Sets of Mitsubishi-Sulzer Diesel Engines for the "Tatsuta Maru," in the Erecting Shops of the Mitsubishi Shipbuilding and Engineering Works at Nagasaki

was definitely indicated by the *Tatsuta's* performance in trial runs conducted at Nagasaki. She attained a maximum trial speed of 20.93 knots an hour while the *Asama* registered 20.713 knots in her tests and the *Chichibu* 20.653.

"More than 20 years ago continued Mr. Hamada, our company built three ships of the *Tenyo Maru* type at our Nagasaki shipbuilding yard. Steam turbines were adopted for these vessels and their use on ships of that size was unusual in those days. Such satisfactory results were realized with these three vessels, that they acquired a dominant position on the Pacific.

"The subsequent appearance of the Empress and the President ships after the World War, caused the three Japanese craft to sink to a rather insignificant position in the trans-Pacific competition. Cries came from the public that it was necessary for Japan to build superior passenger vessels that the country might regain prestige in the shipping world. The Japan Shipbuilding Society organized a special committee to draft basic designs and plans for projected vessels. After study and investigation the society finally submitted definite plans for three motorship passenger liners of approximately 17,000 gross tons each, to have a speed of 20 knots.

"The Society instructed Baron Chuzaburo Shiba, Dr. Junichiro Imaoka and myself to call on Count Kato, then Premier; Mr. Adachi, then Minister of Communications, and Mr. Yuko Hamaguchi then Minister of Home Affairs, to explain the situation. It happened that just about that time the Toyo Kisen Kaisha's San Francisco service had been transferred to the Nippon Yusen Kaisha, which fact made our project easier of realization.

"It was immediately decided that all of the three motorships should be built at home, this meaning not only the promotion of Japanese shipbuilding but the development of other Japanese industries. The completion of the first ship, the *Asama Maru*, marked an epoch in the Japanese shipbuilding industry, as did the completion of the *Chichibu Maru*. And now the completion of the *Tatsuta Maru* has brought additional significance.

"It was once generally believed that the Diesel engine was not the proper type for use in propelling such large ships because it was supposed to create vibration throughout the hull and cause additional noise from the engine rooms. Japanese shipbuilders, however, were confident that these handicaps could be removed through technical improvement. Their faith was justified in the *Asama Maru* and equally so by the *Chichibu Maru* and *Tatsuta Maru*. Thus the handicaps to motorships have been completely removed and the credit for this goes to shipbuilding technique in Japan.

"Japanese shipbuilders hope eventually to purchase all materials for their craft in Japan, but as yet this is not possible. Even in the case of the *Tatsuta Maru* the Mitsubishi Shipbuilding and Engineering Company could not find the proper quality of certain steel, paints and other materials in this country and were forced, in consequence, to import foreign materials to some extent.

"The policy of concentrating effort and attention upon the Trans-Pacific steamship service is becoming more and more pronounced among the leading nations. Its importance is enhanced by the fact that a mercantile marine force must be considered in connection with naval limitation. In time of emergency, superior passenger boats may have to be converted into cruisers, and it is inevitable that eventually Japan will come in contact with problems arising from superior tonnage and speedy commercial ships.

"According to Lloyd's Register, Japan takes third place in the amount of shipping tonnage, but this country has so far lacked a ship capable of developing a speed of more than 20 knots. The three superior ships, the *Asama*, the *Chichibu* and *Tatsuta Maru*, all have this speed. But their construction is only a step, and we must strive hard to obtain more superior vessels of this kind."

"Tatsuta" Equipment—Hull Construction

The *Tatsuta Maru*, has three continuous decks extending over the whole length, including the upper deck, the second deck and the third deck.

At the forward and after parts of the engine-room the fourth deck and the orlop deck are situated. Over the upper deck are a bridge deck covering nearly the whole length of the ship and a promenade deck extending about three-quarters of the length of the ship. A boat deck about 270 feet long covers the promenade deck, and is raised by two feet at the top of the first-class smoking-room. At the forward end of the boat deck are the captain's bridge and navigation bridge, and at the aft end of the promenade deck a docking bridge is provided. Deck houses are built on the boat deck for engineers' cabins and an electric lift directly communicates with the engine-room and the engineer's cabins. Thus there are nine decks, and the height from the keel to the navigation bridge is 87 feet. The ship is subdivided by 10 watertight bulkheads into fore peak tanks, No. 1, No. 2, No. 3 cargo holds, cargo-oil and fuel-oil tanks, auxiliary engine-room, main engine-room, fresh water tanks, Nos. 4 and 5 cargo holds and aft peak tanks, and is so designed as to be quite safe when any two adjacent compartments are flooded. The double bottom extends the whole length and is used for the storage of fuel oil and fresh water.

The promenade deck covering the main part of the ship is taken as the strength deck. Consequently, the ratio of the length and depth is small in comparison with that of ordinary ships. There are no expansion joints, so that the deck and longitudinal cabin bulkheads are compensated to withstand stresses. In the bottom structures the height of the double bottom under the main engine-room is increased and many side girders are added which extend considerably beyond the engine-room bulkhead, while weight saving is obtained by reducing the thickness of the outside plating.

The engine beds are rigidly fastened to the tank top with four rows of bolts, while the tops of the side girders and floor plates are in actual contact with the inner bottom plating. The connection of the side frames and the double bottom plating under the engine-room is reinforced, and special web frames are arranged in four or five frame spaces. Main pillars are provided in four rows and as many more are fitted as the cabin arrangement permits. In this way vibration has been reduced to a negligible amount.

Vibration Prevented

For the prevention of vibration due to the propellers numerous web frames are fitted to the aft peak tanks and shaft tunnels. Not only are all watertight bulkheads extended to the upper deck, but also many fire preventing steel bulkheads are fitted on all decks above the upper deck.

As regards the prevention of noise from the engine rooms, elaborate sound penetration experiments were carried out with various sound preventing materials. Amorsite flaps consisting of asbestos materials having shown the best results in the experiments, all inner surfaces of the main and auxiliary engine room bulkheads, and all casings and walls between the engine rooms and cabins are lined with this material, all of not less than two inches in thickness.

Engine Room

The engine rooms are divided into a main engine room and an auxiliary machinery room. In the former are installed the main engines while the latter is provided with electric generators, boilers and their auxiliaries.

The main engines are installed under the second deck, as they require limited height for lifting pistons. The space above the engine room can be utilized for crew's cabins and galleys, and consequently the deck arrangement, was easily and comfortably designed.

To ensure the rapid handling of cylinder covers and pistons four sets of 2½-ton cranes are provided at the top of the main engine room and all operations for the lifting are carried out by hand.

Five ventilating machines on the air to the main and auxiliary engineboat deck and two others supply fresh rooms respectively, thus enabling the air in the engine rooms to be changed 40 times per hour.

Main Engines

The main engines of the Sulzer type are of the same design as those of the sister ship *Asama Maru* but were built in Japan by the Mitsubishi Works at Nagasaki.

Each of the four engines has eight cylinders, 680 mm. in diameter, with a piston stroke of 1,000 mm., the total normal output being 16,000 s.h.p. at 120 r.p.m. Except the injection-air compressors and the fuel-oil pumps directly connected to the main engine all the auxiliaries are electrically driven.

Each engine is provided with two sets of injection-air compressors, connected at the fore end of the engine with 180-degree crank angles. The compression is in three stages, the low pressure being double-acting. If two or three compressors break down the rest will supply ample air to enable the four engines to work at full power.

The manoeuvring platforms are at the forward end of each engine and on the engine room floor ; all necessary handles, indicators and signals are concentrated there, ample space being provided at the front of the engines.

The fuel-oil pumps are driven by eccentrics from the air compressors and are situated near the manoeuvring platform so that inspection is easily carried out.

Auxiliary Machinery

For the supply of scavenging air to the main engines three sets of Brown-Boveri turbo-blowers are provided, one acting as spare. The blowers are directly connected to 363 KW. electric motors, and each can supply 1,200 cubic metres of air per minute against a head of one metre of mercury.

These blowers are installed in a suction chamber ; the air from the boat deck is taken to this chamber through vertical trunks insulated against noise and is drawn in by the blowers. This chamber is provided with another suction from the main engine room so that the blowers can assist ventilation of the engine room whenever necessary.

In order to simplify the piping system the lubricating-oil and cooling-water systems are independently arranged on both sides of the ship. Two sets of electrically driven geared lubricating-oil pumps and centrifugal cooling-water pumps are provided for the two main engines on each side, of such capacity as to allow one of each type of pump to remain as spare.

The cylinders and cylinder covers of the main engines are cooled by fresh water, for which three electrically driven centrifugal fresh-water pumps are provided, leaving one as spare. The fresh water from the pumps after cooling the cylinders and covers returns to the double-bottom cooling fresh-water tank through coolers. The salt water from the cooling salt-water pumps cools the pistons, exhaust manifolds, air compressors, fresh-water coolers and lubricating oil coolers.

To give warning of the sudden stopping of lubricating pumps alarm lamps are fitted to the driving motors. Alarm whistles and bells are provided to notify the stoppage of flow in the lubricating-oil and cooling-water pipes.

Heating System

Both the electric and steam heating systems have been adopted on the *Tatsuta Maru*. The first-class dining saloon, corridors, swimming pool, gymnasium, the second-class public rooms, officers' and engineers' cabins on the boat deck, crew's compartments, the third-class cabins and public rooms, hospital, offices, etc., are steamheated, while all the first-class public rooms, the first and second-class staterooms, etc., are electrically heated.

The electric heaters for the first and second-class cabins are decorative space heaters provided by the Mitsubishi Electric Works, numbering 129, while for the first-class public rooms and suite rooms 60 Archibald Low's Morganite electric heaters are installed.

Natural and mechanical ventilation is adopted. The electric ventilating machines are of the noiseless slow-speed type of the Thermotank Co., and are installed on the deck-house roofs for the supply and exhaust of air all over the ship. The total number of electric ventilating machines is 78, of 150 h.p. ; the length of the ventilation trunks 13,000 feet, and the number of Punkah louvres is 1,400.

Wireless Equipment

The wireless equipment of the N. Y. K. liner *Tatsuta* Maru is of the latest Japanese make and has a short-wave equipment. The transmitters comprise a 2-KW. main transmitter, a ½-KW. auxiliary transmitter, and a ¼-KW. short-wave transmitter. The receivers are also for long, medium and short waves. The motor lifeboats are equipped with wireless apparatus.

The aerials are in four lines, the fore-half being for 200-3,000 meter waves, and the aft-half for transmitting 600-2,400-meter waves and for receiving 2,000-20,000-meter waves. Further, there are two lines of aerials for short waves and one for wireless telephony. Band reproducers of the newest type are fitted to all the public rooms and promenades.

Refrigerating Plant

The motorship *Tatsuta Maru* having a 300-ton frozen-cargo hold, a 280-ton refrigerating provision store, ice boxes and ice-water tanks, two sets of 190,000 B.T.U. electric refrigerating machines are installed. These are of the double-acting CO2 type, and each has independent circulating pumps. For the cold cupboard in the galley, another brine circulating pump is provided. One machine can keep all the cold stores at the required temperature, even in equatorial regions, by running 12 hours per day, and and can also make ¼ ton of ice.

Navigating Appliances

The navigation appliances of the liner *Tatsuta Maru* include a gyro compass of Sperry alternating current type, with the main gyro on the middle of the boat deck. Steering repeaters are installed, one on the gyropilot, one in the wheel house, one on the roof of the wheel house, one in the captain's room and one for the radio direction finder. An automatic course indicator is also provided. A Sperry automatic steerer of the magnetic-clutch type is fitted in the wheel house.

To control four sets of main engines both side telegraphs are mechanically connected to operate together. Two sets of steering and docking telegraphs and one set of anchor telegraphs are provided. Electric revolution indicators are fitted. Electric propeller signals designed by the Nagasaki Mitsubishi Works, give information to the bridge by four red and green lamps regarding the rotation of the propellers.

A hydraulic Sal log is provided. One of the indicator dials is fitted in the wheel house and the other is in the captain's bedroom.

The change of fore and aft draughts is shown on an indicator fitted in the first mate's office. The sounding machine is of the newest electric type. Two clear-view screens, a wireless direction finder, a 1½-meter rangefinder and an 18-inch searchlight are fitted. Loud-speaking telephones intercommunicate with the wheel house, main and auxiliary engine-rooms, steering-gear compartment and the docking bridge.

Life Saving Appliances

Life saving appliances were installed aboard the new N.Y.K. liner *Tatsuta Maru* in accordance with the latest requirements of the Japanese Government regulations, the United States Steamboat Inspection Service and the British Board of Trade, and, moreover, they comply in all respects with the rules recently laid down by the International Convention for the Safety of Life at Sea, 1929.

The outfit of lifeboats includes 12 Class 1A lifeboats, six decked lifeboats, two motor lifeboats with 35 h.p. engines (the latter having wireless and searchlights and a sea speed of 7.5 knots), all of 30-ft. length and approved for 60 to 70 persons. Further, one 24-ft. emergency boat and one 24-ft. Japanese junk are provided.

Notable features of the equipment of the lifeboats are the adoption of hand-propelling gears and disengaging gears.

14 Pairs of Davits

For handling the boats, six pairs of davits of the gravity type and eight pairs of the quadrant design have been supplied. The davits are worked by 12 boat winches coupled to motors.

Further, eight buoyant apparatus, 18 lifebuoys and two night buoy are provided, the latter being throwable by special electric motors.

The steering gear, is of the electric-hydraulic type, with two sets of Janney pumps and 55 h.p. electric motors, one being a spare. The steering gear can be controlled by a telemotor, by Sperry's two-unit self-steerer in the wheel house, or by hand on the docking bridge. The electric motors can be controlled by a push-button in the steering-gear compartment. Siemen's electric helm indicator and the Sperry self-steerer are installed in the same compartment.

Twelve 5-ton winches and four 3-ton winches are installed for five hatchways. The derrick booms are steel-drawn tubes of 238 ft. to 50 ft., which are fitted to two masts and two derrick posts.

Seventeen automatic hydraulic watertight doors are fitted, which can be immediately controlled from the navigation bridge in case of emergency. Two electric-hydraulic pumps and accumulators are installed in the auxiliary machinery room.

Emergency Generator

An emergency generator is fitted on the middle part of the boat deck.

The fire doors have automatic rolling shutters and art-metal sliding doors. For fire prevention fire alarms and fire extinguishing apparatus are fitted. For the cargo holds, provision stores, baggage rooms, silk stores, mail rooms, paint rooms, lamp rooms, engine rooms, etc., CO2 gas pipes are arranged, 60 CO2 gas bottles being fixed in the engine-room. Hand fire-extinguishers are provided in many places. Further, alarms are fitted to every cabin and public room, so that any fire will at once be notified to the navigation bridge.

For emergency pumping a vertical pump is installed in the engine room, and this will discharge 140 tons of water per hour.

Far East Line to be Inaugurated by Blue Star Interests

The Blue Star Line is about to inaugurate a new service on modern cargo vessels between the United Kingdom and the Far East, the British port of entry being Newport. The new line will be called the Far East Line, and will work in joint arrangements with Alfred Holt (the Blue Funnel Line) and the Ellerman & Bucknall Steamship Co.

The Blue Star Line will place the following ships on the service: *Tacoma Star* of 7,897 tons, *Albion Star* of 7,920 tons, *Doric Star* of 10,440 tons, *Royal Star* of 7,900 tons, *Fresno Star* of 7,998 tons, and the *Trojan Star* of 9,000 tons. A trial voyage with the *Tacoma Star* was made, leaving Antwerp at the end of February. The *Albion Star* leaves Antwerp at the end of March, and Hamburg early in April.

Arrangements will then be made to make the schedule for monthly sailings as follows: Newport, Antwerp, and Hamburg for the following Far Eastern ports:—Penang, Port Swettenham, Singapore, Hong Kong, Shanghai, Kobe, Yokohama, Tientsin.

After very lengthy negotiations the Blue Star Line is about to join the Far East Conference. It is interesting to recall that about 20 years ago the Blue Star Line was associated with the Chinese trade. The new line will be managed from the Blue Star offices in London, in combination with the other joint lines mentioned. The chief members of the Conference are:—Hamburg-Amerika Line, Norddeutscher Lloyd, Hugo Stinnes Linien, Ellerman & Bucknall Steamship Co., Ltd., Peninsular & Oriental Steamship Navigation Co., Messageries Maritimes, Chargeurs Reunis, Navigazione General Italiana, Stoomvaart Maatschappij "Nederland," Rotterdamsche Lloyd, Holland-Oost Azie Lijn, Campagnia Trasatlantica de Barcelona (Larrinaga & Co.), East Asiatic Co., of Copenhagen, Swedish East Asiatic Co., of Gothenburg, Norwegian Africa and Australia Line, Glen Line, Shire Line, Ben Line, Mutual Line, Mogul Line, Nippon Yusen Kaisha, Osaka Shosen Kaisha.

Agreements are in operation for rebates of 5 and 10 per cent. up to June 30, 1931. This Conference is now the largest in the world, and the competition is proportionately keen. The progress of the new Far East Line will arouse immense interest throughout the shipping world.

Another recent event of importance concerning the Far Eastern shipping trade was the launching of the steel twin-screw steamer *Registan* from the South Shields yard of John Redhead & Sons, Ltd., for Frank C. Strick & Co., Ltd., of London. This vessel is designed to carry about 8,950 tons on a light draft, and is of the following dimensions:—Length overall 440 feet 3 inches, breadth 55 feet, moulded depth 31 feet. She is of the two deck type, having poop, bridge and topgallant forecastle, and has been specially designed for trading in the Far East. Water ballast is carried in the cellular double bottom all fore and aft, also in the fore and after peak tanks and deep tank. The cellular double bottom is also adapted for the carriage of oil fuel.

The vessel has been constructed to Lloyd's highest class under their special survey, and complies in every way with the British Board of Trade and Factory Act latest requirements. A complete equipment of fifteen double steam winches and steam derricks is fitted at the large cargo hatchways for the rapid handling of the cargo, and a 30-ton interchangeable heavy steel derrick is also fitted. A complete installation of electric lighting is provided as well as radio telegraphy. An up-to-date refrigerating plant is also installed.

The vessel is fitted with triple expansion engines, also constructed by the builders, with cylinders 28-in., 46-in., 78-in. diameter by 51-in. stroke, working in conjunction with a Bauer-Wach low pressure exhaust turbine. Steam is supplied from three large boilers operating at 210 lbs. pressure per square inch, and fired with oil fuel and/or coal under forced draught. The official trial proved in every way satisfactory to all concerned.

Canadian Pacific's Enormous Program

Of the enormous sum of £78,000,000 spent by the Canadian Pacific during the last ten years on new general equipment, approximately £20,000,000 has been expended on new vessels built entirely in British shipyards. In addition, millions of pounds have been spent in Britain in ship overhaul, reconditioning, etc.

Speaking in Toronto recently, President F. W. Beatty said the Canadian Pacific had built an almost new fleet since the War, leaving only three vessels in service that were in operation at the outbreak of hostilities.

"In our Princesses, Duchesses, and Empresses," he declared, "we have set a newer and higher standard of steamship service in Canada and between Canadian ports and those elsewhere."

The largest of the new vessels referred to by Mr. Beatty have been built for the trade between the Far East and the American Pacific Coast.

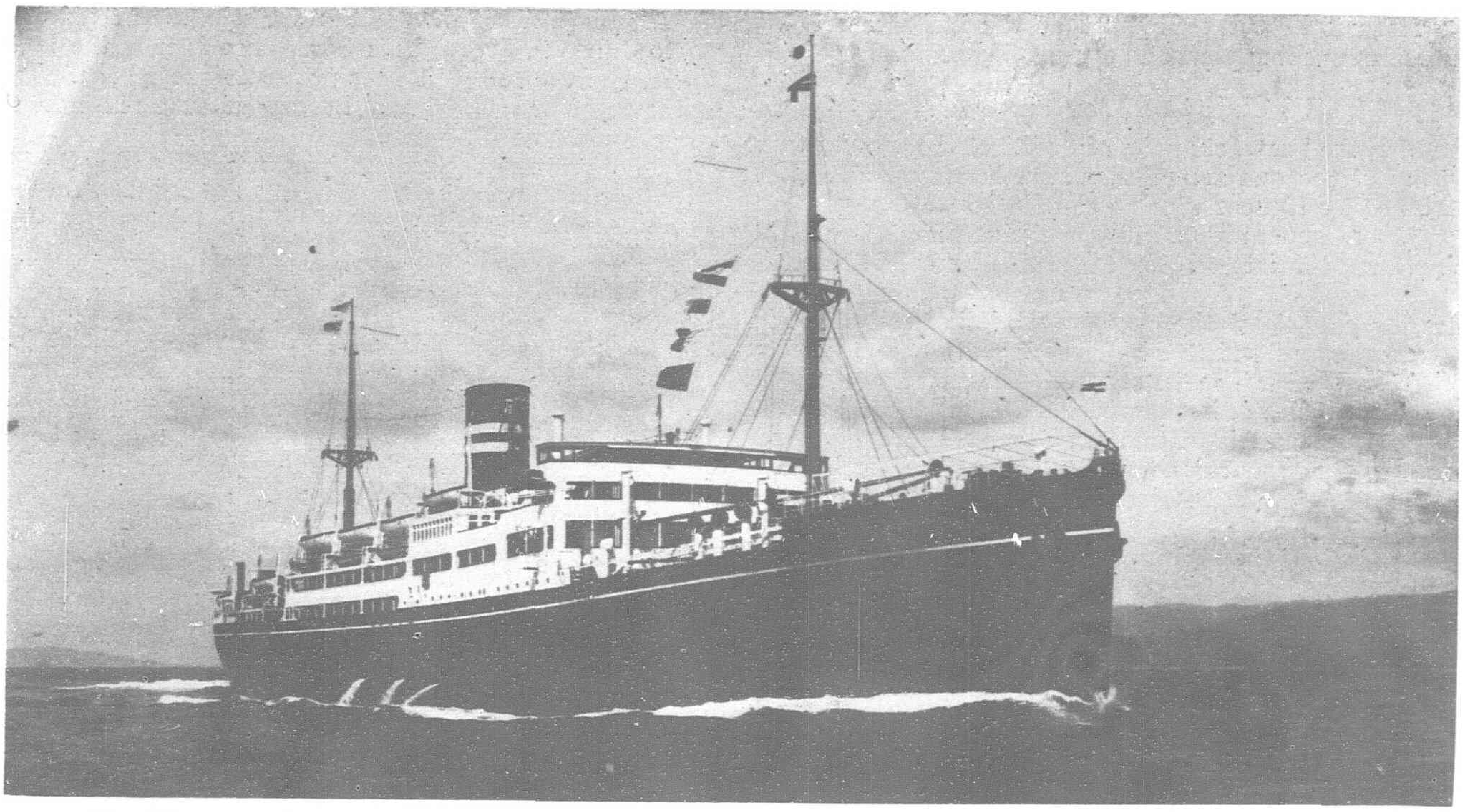
Diesel Traction on the Buenos Aires Great Southern Railway

(Continued from page 240).

the engine and the auxiliary apparatus is therefore kept narrower at the top in order to give the driver a free view in either direction. Fig. 10 shows the Diesel engine for this locomotive on the test-bed in the Sulzer Works at Winterthur. The mechanical part was built by Armstrong, Whitworth & Co., and the transmission gear by Vickers Ltd.

The Buenos Aires Great Southern Railway has also ordered a small locomotive built for hauling light trains (fig. 11). For this a six-cylinder Sulzer Diesel engine of 420-B.H.P. has been adopted. Power is transmitted electrically from the engine to the axles. The four electric motors driving the small locomotive are fitted by tram suspension in the two-axled bogies. This locomotive is designed on the lines of a rail car, being fitted with a luggage compartment. The driving motors for this locomotive were supplied by Metropolitan-Vickers and the mechanical part of the vehicle by Armstrong, Whitworth & Co.

The new rolling stock was put into regular service in February, 1930, and has demonstrated the great advantages possessed by this form of traction. On the first trip, when the service was inaugurated, the run from Constitution to San Vincente was accomplished in 40 minutes, whilst the steam trains on the same line take 70 minutes to make the same trip.



The "Buenos Aires Maru," 10,000 Tons O.S.K.'s New Motor Liner for the South American Service, Built at the Nagasaki Works of the Mitsubishi Dockyard and Engineering Company

New O.S.K. Motor Liner "Buenos Aires Maru."*

The Osaka Shosen Kaisha has recently placed on its South American service two new 10,000 ton diesel-engined steamers, the *Buenos Aires Maru* and the *Rio de Janeiro Maru,* the former sailing from Kobe on her maiden trip to Buenos Aires, November 16, 1929.

The *Buenos Aires Maru* was laid down in the Mitsubishi Shipyard on October 15, 1928, launched on May 11, 1929, completed on October 31, 1929.

The vessel is almost 100 per cent. Japanese built. Except for a few foreign patent appliances, the ship's hull, propelling machinery, generators, winches, refrigerating machines, anchors, cables, laundry and galley appliances, disinfecting machines, windows and scuppers, ventilating fans and all other fittings were manufactured in Japan, mainly in the Mitsubishi Shipyards.

The decoration of all the public and private rooms is also in special Japanese style, so that the ship may be considered as representative of Japanese industry.

Principal Particulars

Length overall	482-ft. 0-in.
Length between perpendiculars	460-ft. 0-in.
Breadth, moulded	62-ft. 0-in.
Depth, moulded	39-ft. 6-in.
Draught at full load	26-ft. 0-in.
Gross tonnage	9,625 tons
Deadweight capacity	8,200 tons
Speed	17 knots
Machinery power	6,400 s.h.p.
Main engines	2 Mitsubishi-Sulzer units
Number of passengers :—	
First-class	60
Third-class or emigrants	1,076
Ship's complement	149

The vessel was built under the special survey of the Teishinsho and Lloyd's classified by Lloyd's as 100 A1 "with freeboard" and L.M.C.

General Arrangement and Hull Construction

The liner has three continuous decks, *i.e.*, the upper deck, the second deck and the third deck. Over the upper deck there are a forecastle deck at the bows, a bridge deck in the middle, and a boat deck over the bridge deck.

The hull is divided by seven watertight bulkheads into eight compartments, *i.e.*, an engine-room, five cargo holds, and the fore and aft peak tanks. The first, second and third cargo holds are arranged forward of the engine room, and the fourth and fifth cargo holds aft.

The deckhouse at the forward end of the boat deck comprises the captain's and officers' cabins, and on its top a flying bridge is constructed, where a wheelhouse, a chart-room and a gyrocompass room are arranged. The compass bridge is above the flying bridge, where a standard compass is fitted.

Aft of the deckhouse on the boat deck the first-class social hall is situated. Aft of the social hall are the first-class smoking-room, verandah, wireless office and operators' cabin.

On the bridge deck are the Japanese and European galleys, engineers' cabins, various offices, a doctor's cabin, clerks' cabins and a barber's shop. The seamen's quarters are under the forecastle deck, and the oilers' and mechanics' quarters on the second deck astern. On the aft part of the upper deck are a spacious laundry, emigrants' wash place and a disinfecting room.

On the third deck are the first-class passengers' baggage-room, rice stores, provision stores and silk stores. There is a refrigerated cargo space of 300 tons capacity.

Japanese-built Engines

The main engines consist of two sets of Mitsubishi-Sulzer Diesel engines running at 120 r.p.m. ; the total designed output is 6,400 s.h.p. The engines have six cylinders with a diameter of 680 mm., the stroke being 1,000 mm., and two sets of injection air compressors are fitted at the fore end of the engines.

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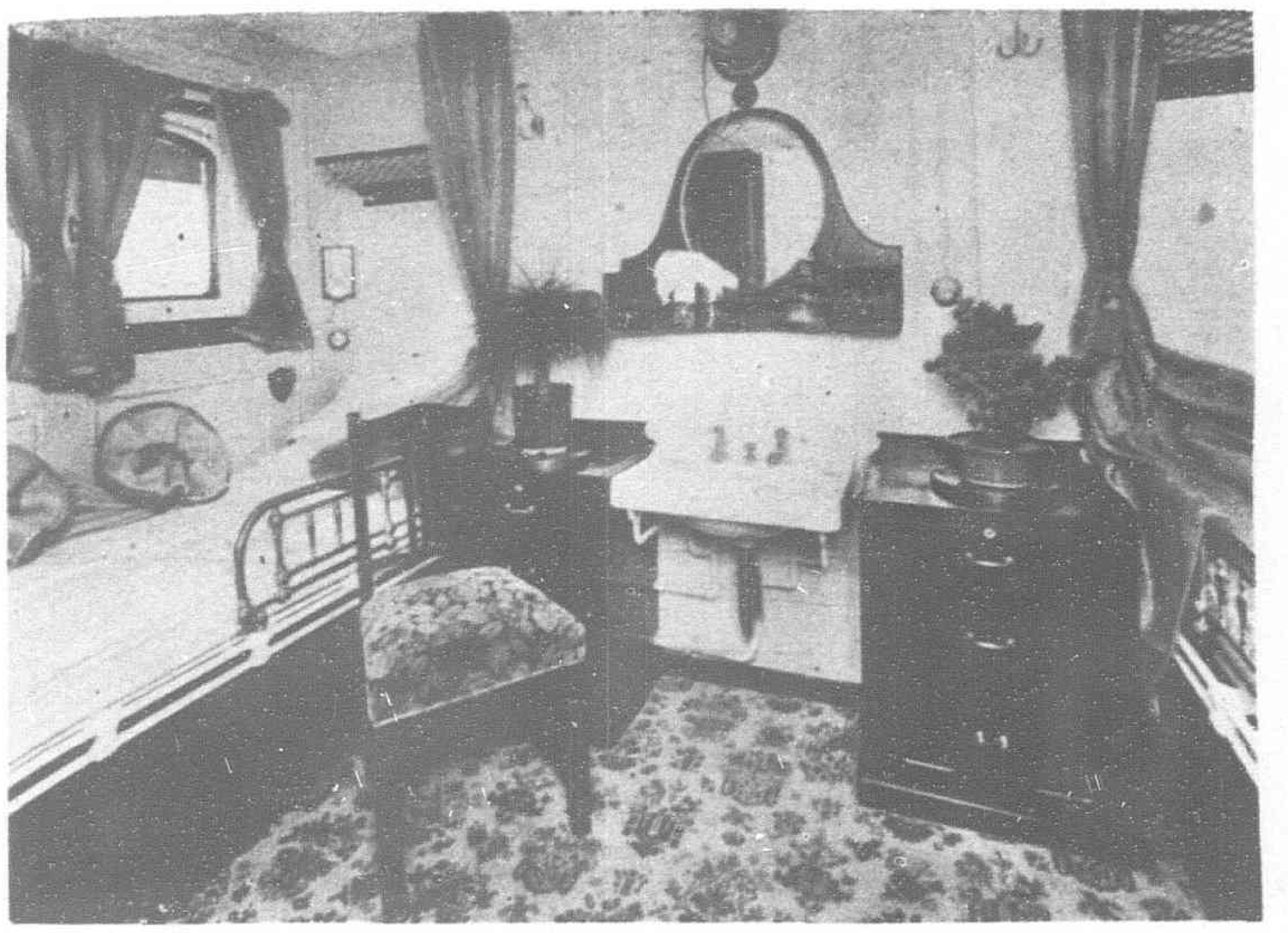
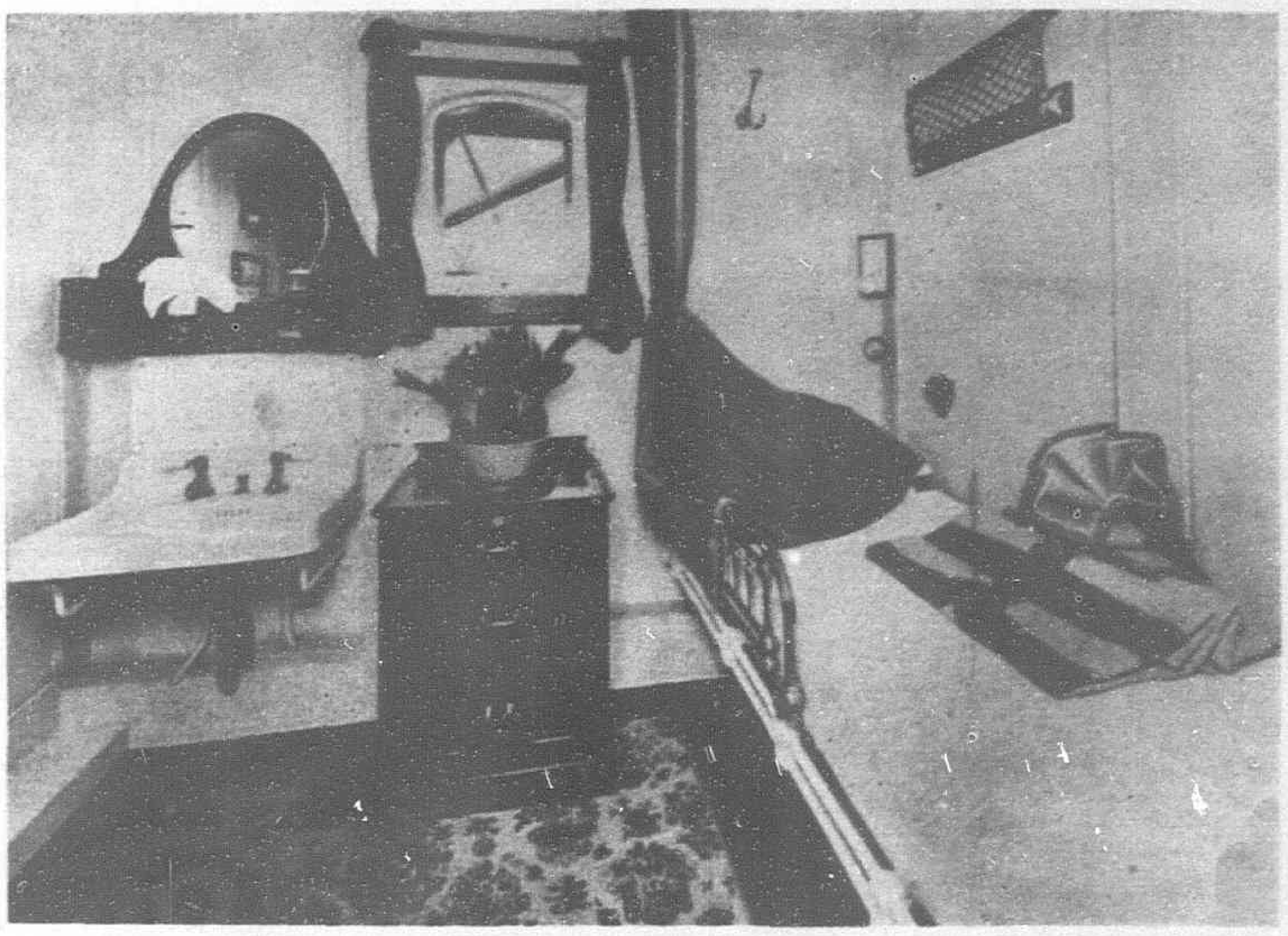
*From "Motorship"



First Class Cabin (Double)



First Class Cabin (Single)

All other auxiliary machinery for the main engines is electrically driven, and a control platform is arranged at the lower part of the fore ends of the engines, where all necessary appliances for manoeuvring are assembled.

Electrical auxiliary machinery directly needed for the main engines is as follows :—

Two sets of Brown-Boveri turbo-blowers of 275 KW. each.

Two sets of Mitsubishi jacket-cooling sea-water pumps, each of 250 tons per hour.

Two sets of piston-cooling freshwater pumps, each of 60 tons per hour.

Two sets of lubricating oil pumps, each of 46 cubic metres per hour.

Two sets of auxiliary air compressors, each with a capacity of 600 cubic metres per hour.

The generators comprise three units of 230 KW. dynamos directly connected to Mitsubishi airless-injection fourstroke Diesel engines. The operation of these engines is extremely good, and their fuel injection is on the Vickers system. Using low-grade oil, as in the main engines, no sudden increase of pressure due to the explosive combustion has occurred ; knocking and vibration are absent, and the performance quiet and smooth.

First-class Passenger Accommodation

The first-class social hall is the finest room in this ship, the decorations being carried out in a modernized version of Japanese ancient style. The type of decoration from which it originated was to be found in the aristocratic Fujiwara Era of the eleventh century, and the characteristic of elegant feminine taste is modernized in this decoration. In the middle of this room a large dome is constructed and a stage is provided in the front, while the aft two sides serve as reading-rooms. The main wall materials are lacquered hard wood. The small walls are lined with palm leaf cloth, the upper parts of the walls with waved plaster, and the lower lining with Japanese fan-shape wood carving. In the front of this room a fine Japanese painting is arranged, showing a cheery blossom fete in the Momoyama Era of the sixteenth century. In the reading-rooms Japanese paintings are hung, showing manners and customs of the same period.

In the aft part of this hall is a staircase which communicates with the bridge deck. On the wall just behind the staircase some representative Japanese prints of the most prosperous Kkiyoye Era of the Tokugawa dynasty are hung, while the piano on the stage is decorated with lacquer paintings.

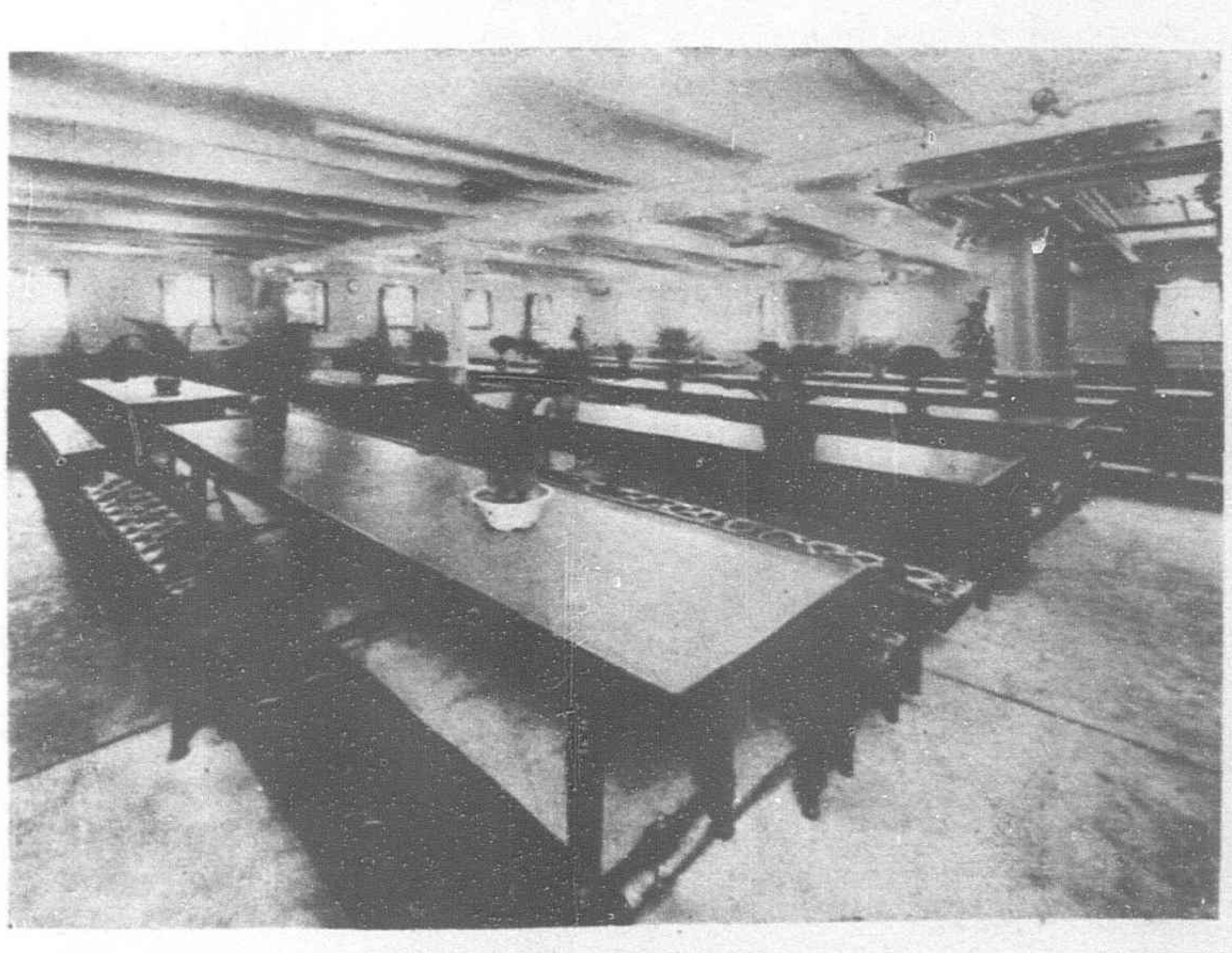
Through the side doors of the social hall passengers can pass directly out to the glass-covered promenade deck. On the same deck is the first-class smoking-room, modelled on a " Samurais" library in the Tokugawa Era and modernized to suit the comfort of passengers, as in the social hall. A heater in the center of the room represents a popular old native fireplace.

Behind the smoking-room is a verandah. Below the staircase of the first-class social room is the first-class entrance hall, decorated in the style of an old " Samurai " house in the Tokugawa Era. An inquiry office is provided there

The first-class dining saloon is situated at the foremost part of the bridge deck. This is the largest room on board, measuring 46 ft. by 23 ft., with a 'tween deck height of 10 ft., and is also decorated in a modernized Japanese style. The walls are finished in light blue lacquer. Seventeen dining tables and 60 chairs are provided.

The first-class staterooms are arranged on the bridge deck, comprising six single rooms, 25 double rooms, and two special suite

Third Class Cabin



Third Class Dining Room

rooms on the starboard side, accommodating 60 passengers in all. Each room is provided with beds, wardrobe, chairs and washbasins with hot and cold running water. The special suite rooms have a private bathroom and a baggage-room.

Third-class Passenger or Emigrant Accommodation

The ship being designed mainly for the transport of emigrants to South America, various special arrangements are made for the third-class passengers. The second deck is almost wholly devoted to cabins for emigrant passengers, and 1,076 can be accommodated ; there are also a few cabins on the upper deck, so that the vessel carries the largest number of emigrants of any Japanese ship. The distribution of the emigrant passengers' cabins is as follows :—

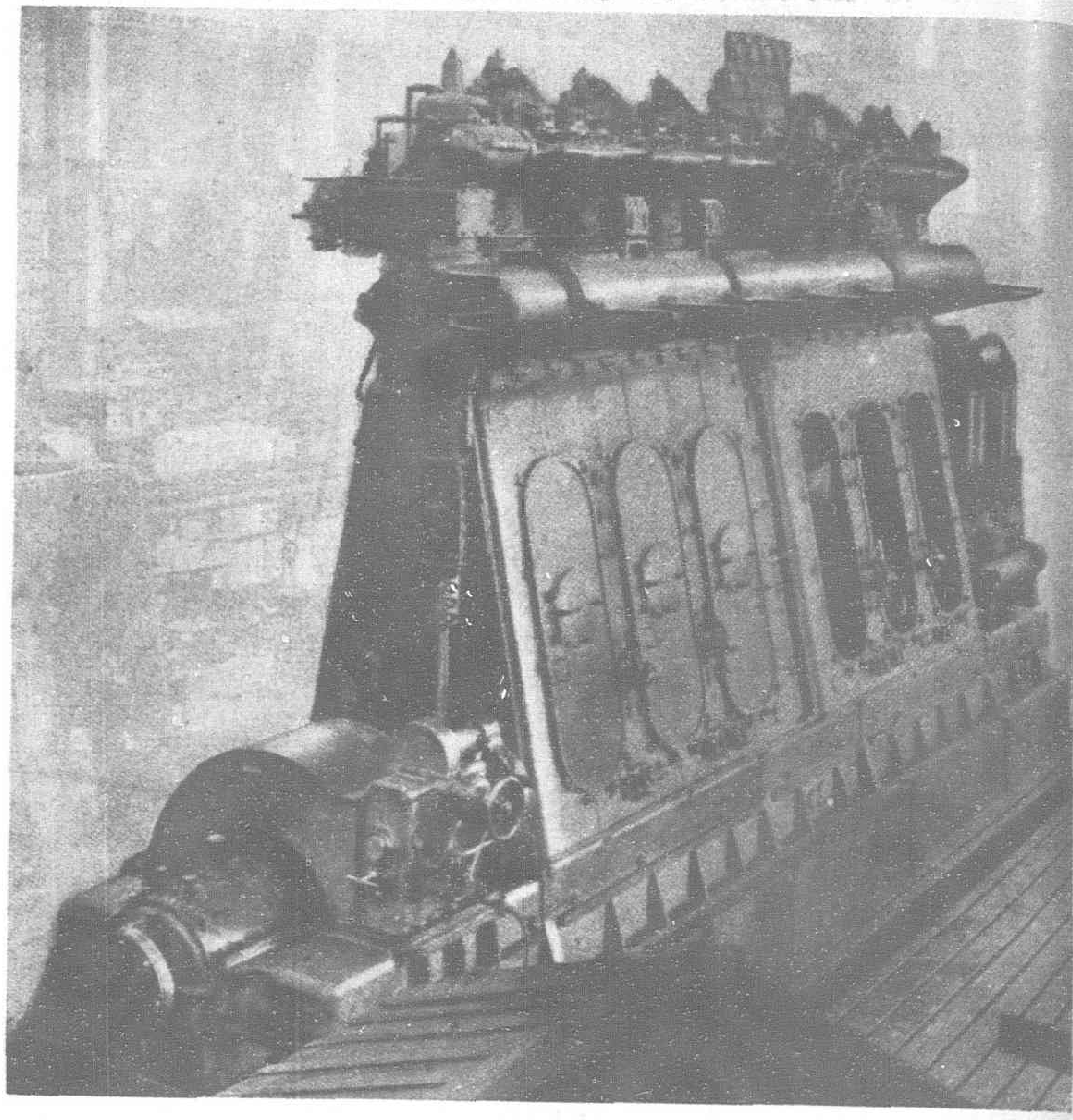
Second deck.

First compartment	126 persons
Second compartment	226 persons
Third compartment	170 persons
Fourth compartment	316 persons
Fifth compartment	188 persons
On the upper deck, port side only	50 persons
Total	1,076 persons

On the second deck, except the third compartment, passengers are accommodated in airy cabins provided with metal berths, which are detachable and may be stored in a corner on the homeward voyage and the space used for baggage.

In the cabins on the upper deck and in the third compartment of the second deck wooden beds are provided. The former is divided into eight-or twelve-berth cabins, while the latter can be altered to four-to ten-berth cabins by detachable wooden walls on the homeward voyage. Consequently, the number of beds may be reduced to accommodate only 104 passengers, instead of 170 on the outward voyage. In these compartments there are over 20 large beds for mothers and children together.

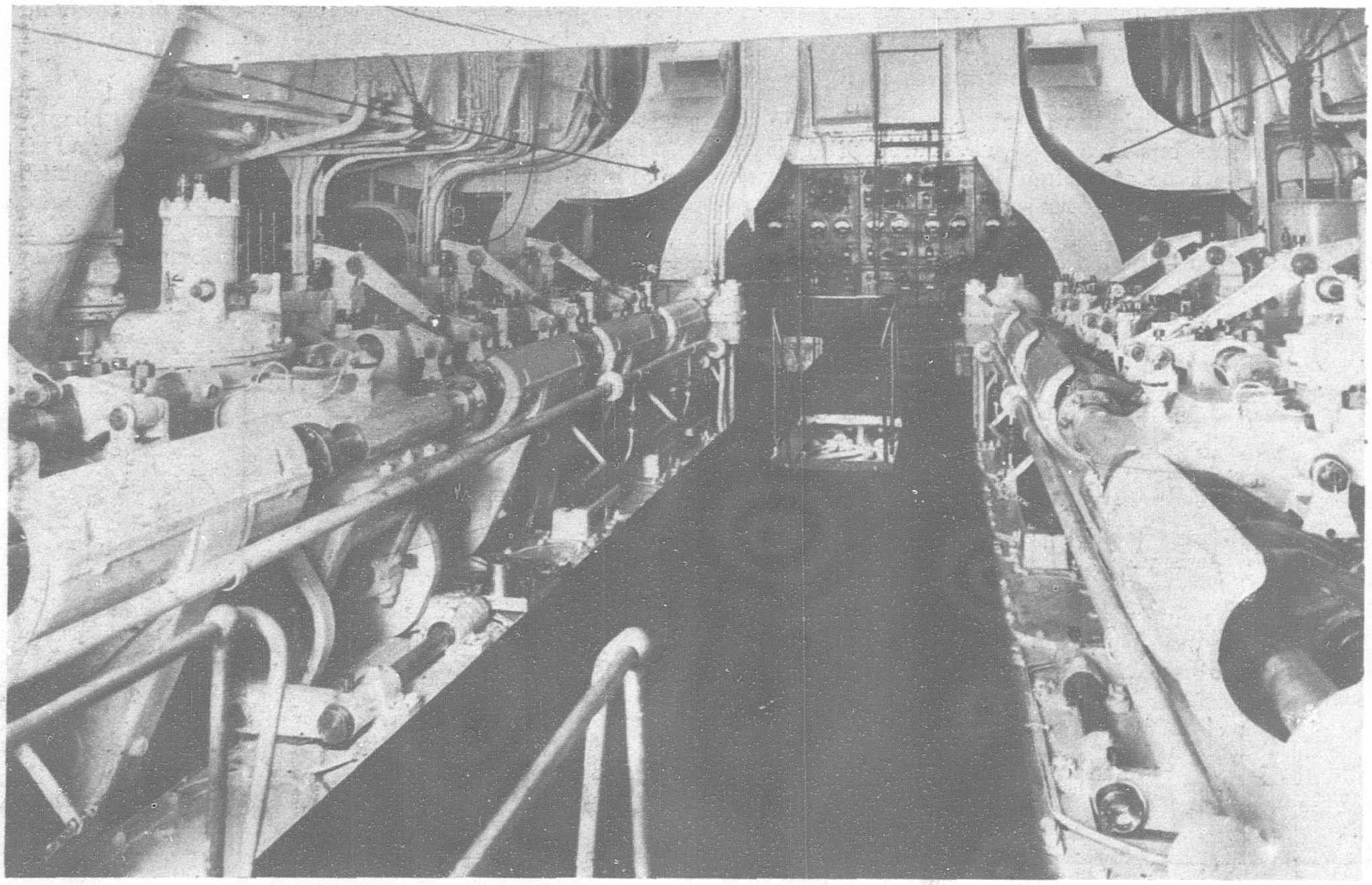
The third-class passengers' public rooms comprise a large dining-room on the forward starboard side of the upper deck below the bridge deck, with a smoking-room and steerage entrance on the aft part of the same deck. The dining-room is large enough for about 160 passengers to be served at the same time ; a large bookcase is provided in the smoking-room. All decorations are in simple modern style and in harmony, being quite unusual for third-class accommodation on this route.



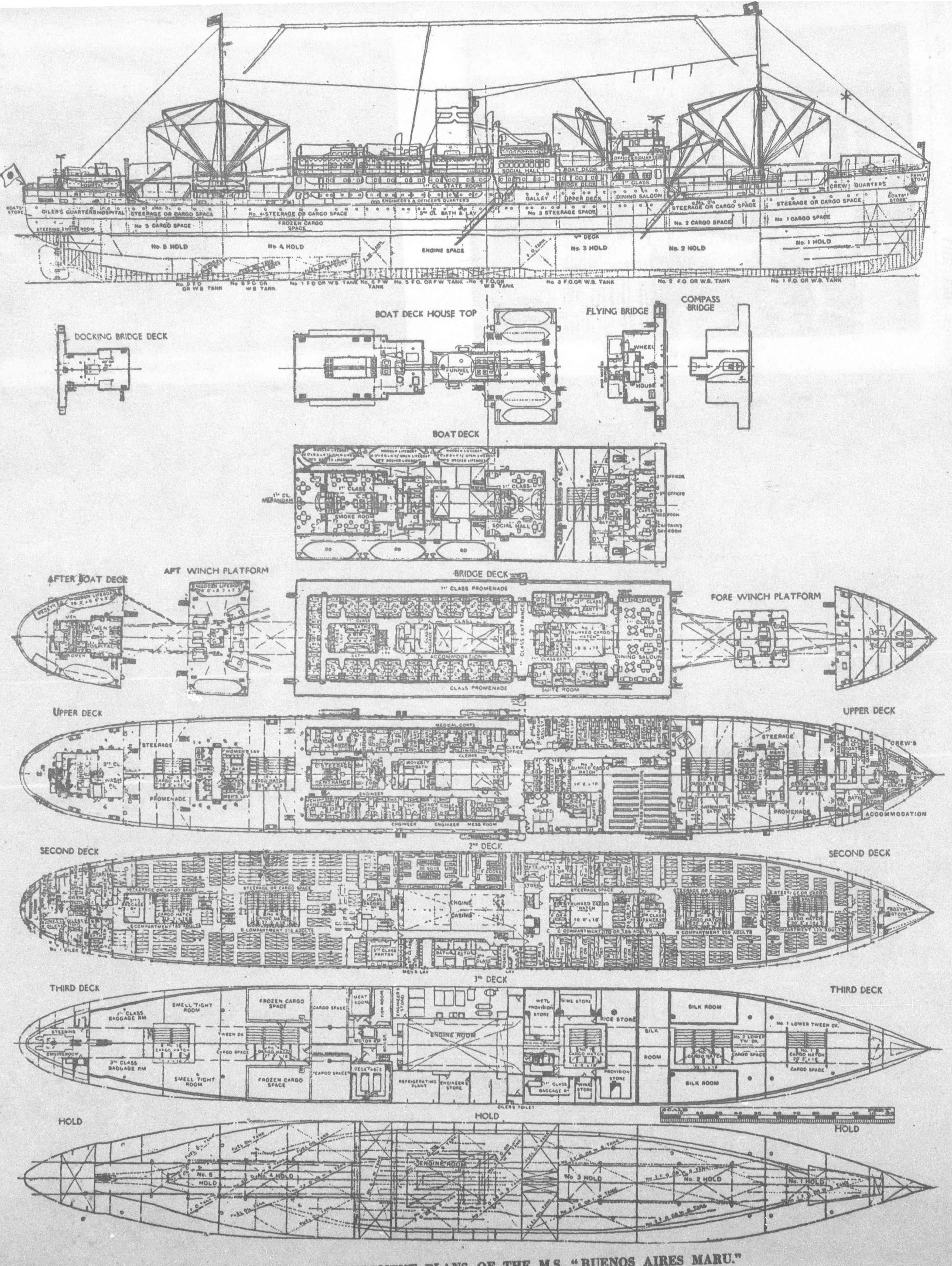
One of the 3,200 S.H.P. Mitsubishi-Sulzer Diesel Engines for the "Buenos Aires Maru"

Ventilation

The ship has to navigate tropical seas with a full number of emigrants, her mileage being over 12,000 and requiring over 40

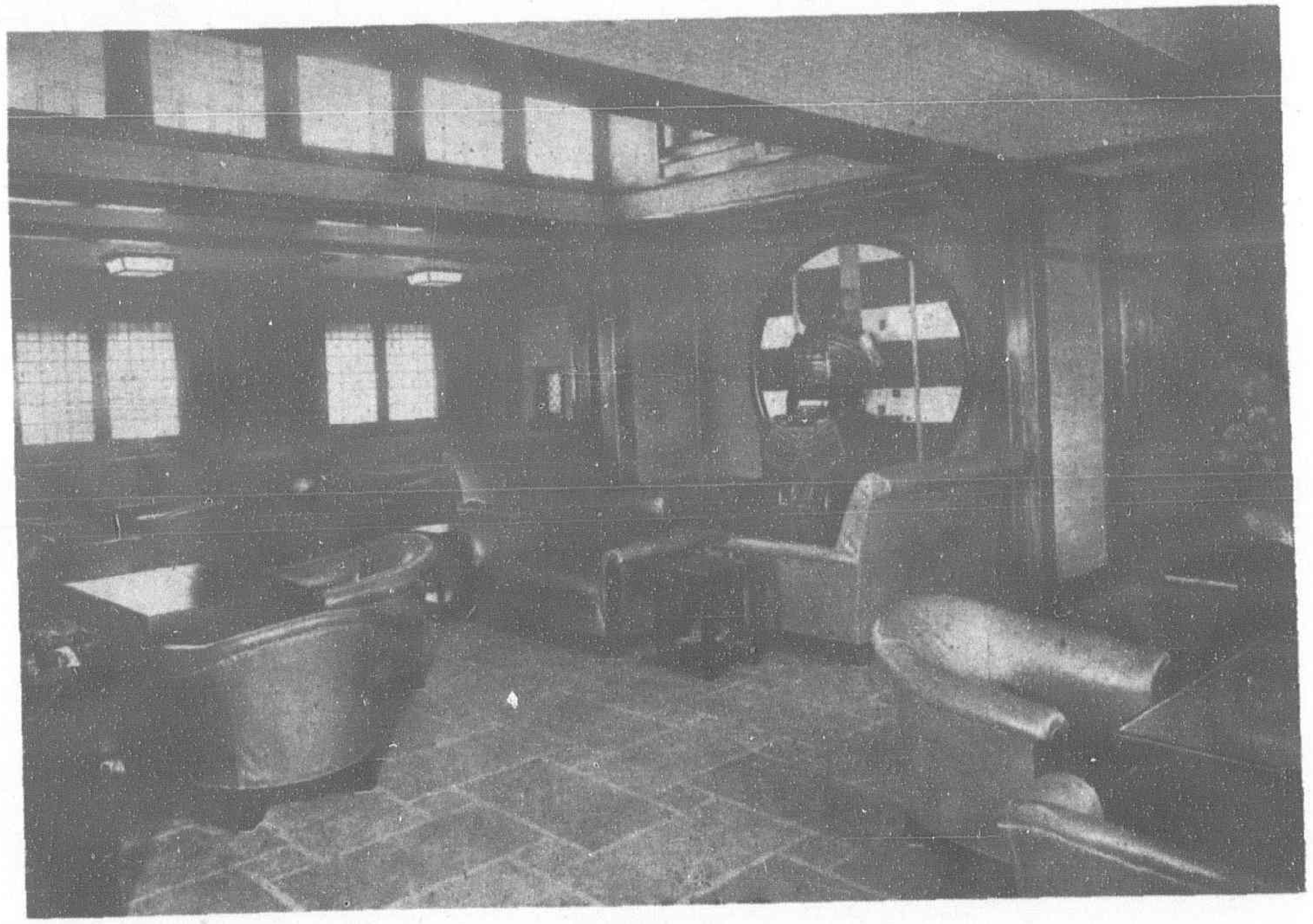


View of Engine Room of "Buenos Aires Maru"

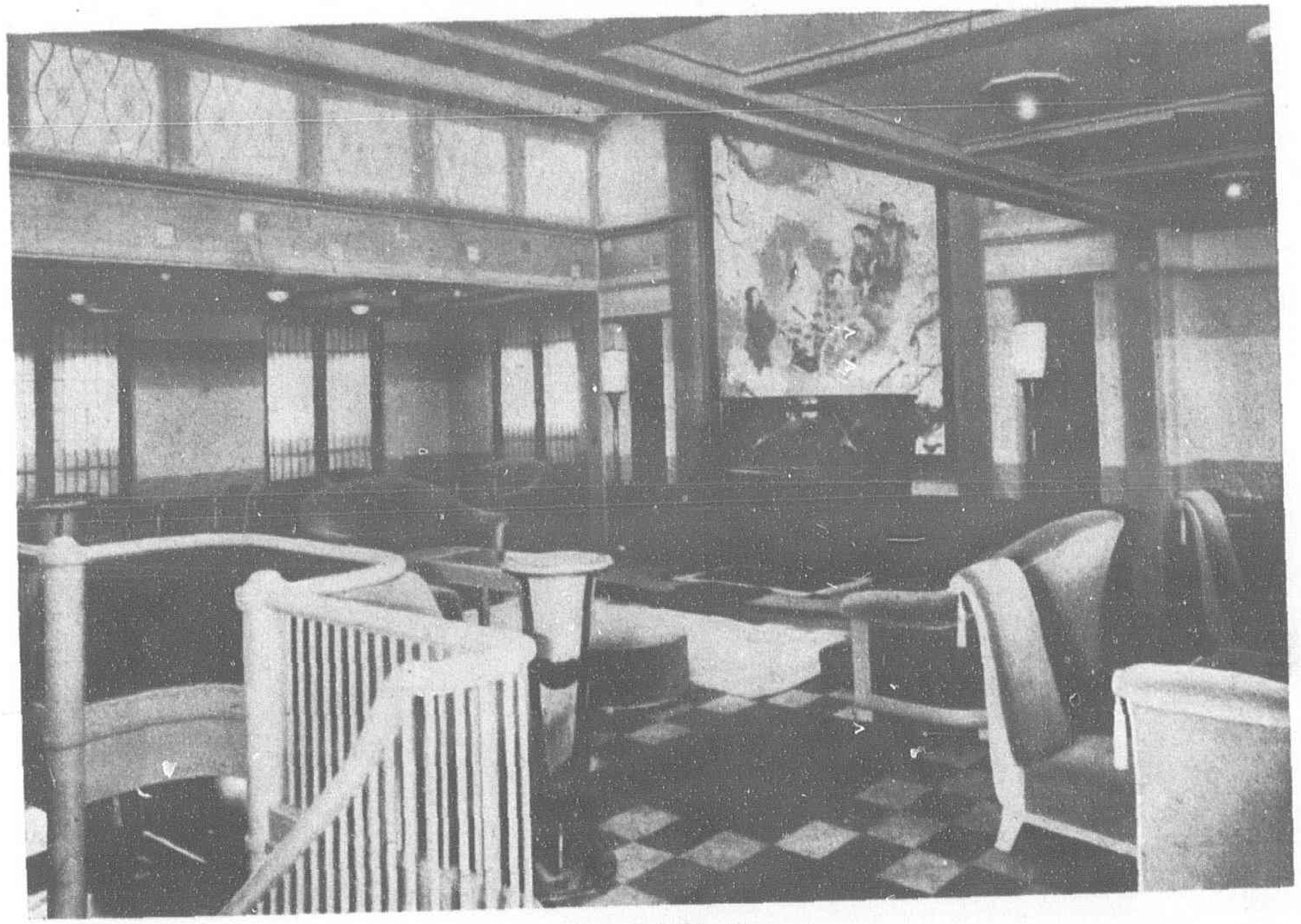


GENERAL ARRANGEMENT PLANS OF THE M.S. "BUENOS AIRES MARU."

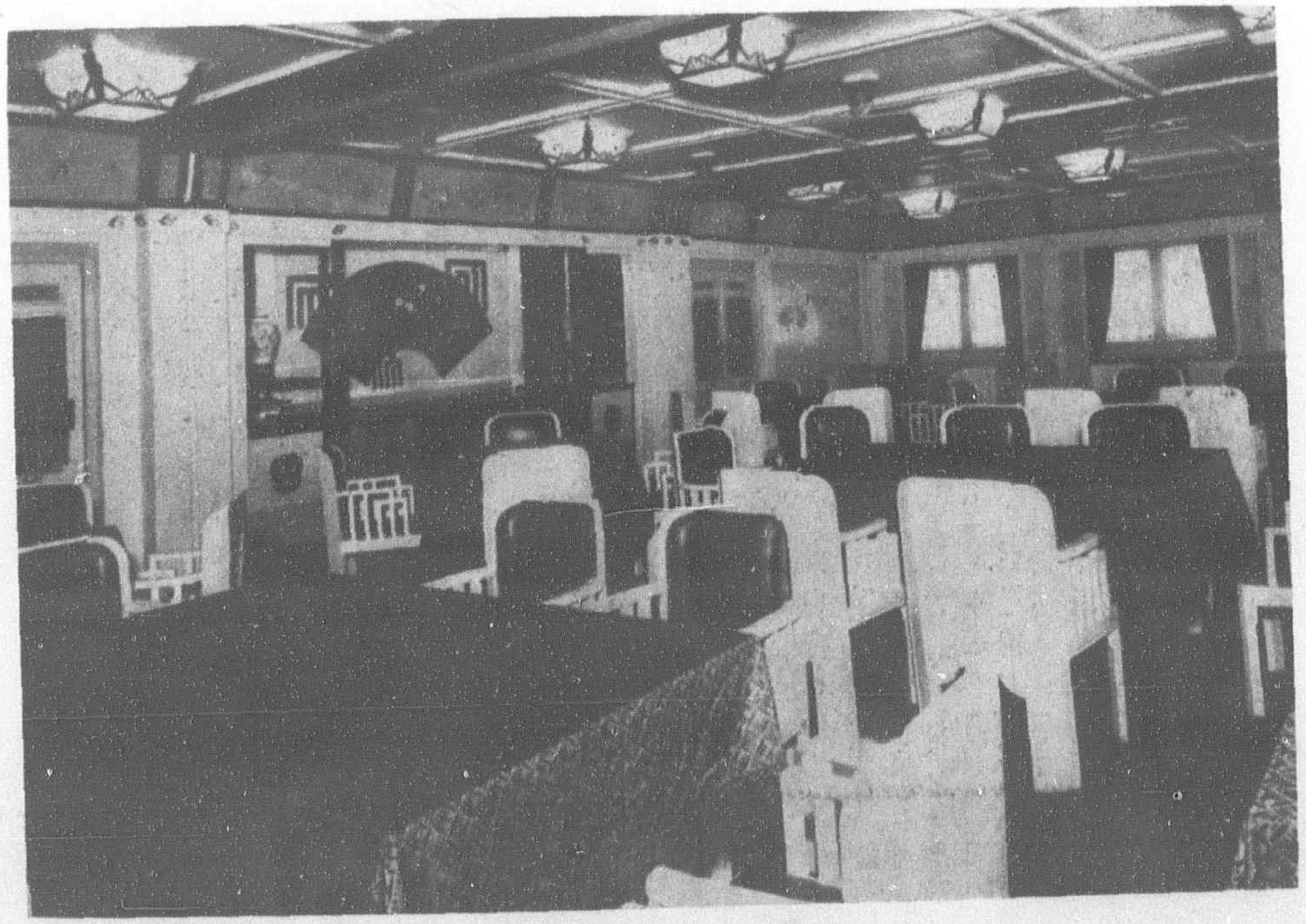
LUXURIOUS PASSENGER ACCOMMODATIONS ON O.S.K. LINER "BUENOS AIRES MARU"



Smoking Room



Social Hall



First Class Dining Room

Social Hall

days for her voyage, so that the arrangements for emigrants are extremely important, particularly in regard to ventilation and the lighting of cabins; to the comfort and health of the passengers every possible consideration has been given.

For the ventilation, not only is ample natural means provided for every cabin, but for the cabins on the upper deck and the third-class compartment, fans are provided to supply outside fresh air. As to the hygienic and sanitary appliances, five bathrooms, eight wash places and eight lavatories are provided on the starboard 'midship portion of the second deck and under the fore and aft winch platforms on the upper deck, which are easily accessible from each cabin. The baths are of Japanese type, all finished with white tiling, and dressing-rooms and clothing shelves are arranged.

Hospitals

A dispensary and operation room are arranged near the third-class smoking-room on the upper deck. There are also two sickbays on the second deck aft and one on the stern boat deck. There is a maternity room on the second deck, where two beds are fitted. On the aft boat deck two isolation rooms for infectious diseases are arranged. All hospitals have their own lavatories and bathrooms for exclusive uses. Further, seven detachable children's beds are provided in case of illness among children, and it is made possible for mothers to stay in the hospitals with their sick children.

As to amusements, there is a cinema, also a swimming pool on the upper deck, and various other provisions are made for exercise.

Safety Appliances

Twenty-two lifeboats are provided under the British Board of Trade's regulations. Six 26-ft., two 28-ft., six 30-ft. open lifeboats, as well as two 26-ft, and six 30-ft. decked lifeboats are arranged on the boat deck. All these lifeboats are worked by Welin Quadrant davits and they can take a total of 1,302 persons.

For the prevention of fire, fire-preventing bulkheads and doors are fitted in accordance with the British B.O.T. regulations. Seventy-five CO_2 gas pipes are arranged in all cargo holds, baggage rooms, silk stores, provision stores, etc., for the extinguishing of fire. Hand fire extinguishers are provided in several places.

Cargo-handling Appliances

For cargo handling, 14 winches and booms are fitted for four cargo hatches at the upper deck and one hatchway at the boat deck. All winches are of the Mitsubishi electric type with a capacity of three tons at 100 ft. per minute, these being fitted with automatic accelerating devices and improved upon the existing types.

The booms are of Mannesman's steel-drawn tubes; the fore mast has two ten-ton booms for two forward hatchways, while the main mast has four six-ton booms for four aftward hatchways, all others being of three tons fitted to the fore and main masts as well as to four derrick posts. Further, two derrick posts with derricks of half-ton capacity are provided for passengers' baggage, and on the upper deck aft a seven-ton Mitsubishi boat-mooring winch is fitted.

The deck machinery, other than that mentioned, comprises an Atlas Werke windlass of 63 h.p., with Atlas safety devices, a Brown Brothers' 35 h.p. steering gear of Williams Janney-Brown electric hydraulic four-ram type, and two sets of refrigerating machines of Mitsubishi construction.

All winches, the windlass, the refrigerating machines, steering gear and cooking apparatus being electric, the electrical output of the ship's dynamos is very large in comparison with other ships of similar type. The main generators are three sets of 230 KW. Mitsubishi Diesel dynamos, and two sets of motor generators for 1,100 electric lamps and 150 ventilation fans.

The navigating appliances include an Anschutz gyro-compass, self-steerer and course recorder.

Trial Results

In the official trials the fuel consumption of the main engines and auxiliary machinery was extremely low. In a six hours' trial, during which the fuel was accurately measured, it was found to be only 183.7 grammes, or 0.405 lb., per s.h.p. per hour for all purposes.

The details of the results of official trials are shown in the following table:—

	Continuous Trials.					Full Power trial.	Fuel consumption trial.
Load	25%	50%	75%	100%	115%	100%	100%
Speed (knots)	11.24	13.5	15.21	16.46	17.01	16.59	16.35
R. P. M.	79.4	98.0	112.8	122.8	127.3	125.2	122.5
I. H. P.	2259	3854	5733	7620	8331	8189	7521
S. H. P.	1653	2957	4604	6275	6885	6761	6201
Scavg. air (Kg/sq. cm.	0.063	0.075	0.090	0.098	0.102	0.103	0.091
Inject. air (Kg/sq. cm.)	49	56	63	68	70	70.2	68
Fuel consumption—Main engines only	187.1	178.2	171.2	172.8	177.9	176.8	173.4
Ditto, including auxiliaries	219.1	198.3	185.8	184.2	188.9	187.4	183.7
Sea water temperature C°	25	25	25	25	25	24	24
Dynamo output (KW.)	185	214	252	270	287	273	240
Turbo-blowers (KW.)	112.8	139.2	176.0	190.3	204.6	187.4	152.7
Picton cooling pumps (kw.)	8.3	8.8	8.9	9.2	9.2	9.8	9.3
Cylinder cooling pumps (kw.)	17.6	18.7	20.3	20.8	20.8	24.8	26.3
Lubricating pumps (KW.)	12.1	13.4	13.2	14.1	15.4	11.9	11.8

N.B.—1. Fuel consumption is in grammes per s.h.p. per hour.
2. The last four items turbo-blowers, etc.) are the input of electricity of the auxiliaries necessary for driving the main engines.

The Modern Bank Vault

By E. J. REED

CONFIDENCE in a bank as a place of security places upon its officers a tremendous responsibility in the protection of valuables.

Not only do Vaults and Safe Deposit Boxes contain Stocks, Bonds, Jewellery and other items of pecuniary value, but documents whose value cannot be figured in dollars and cents—to the owner they are beyond price; in many instances irreplaceable.

Usually in the eyes of the layman and a great many bankers of the Far East to-day, regard the old tea pot as adequate protection to their valuables, a catastrophe will be the only convincing argument of their folly.

In the design of the Bank Vault, there are a number of fundamental requirements which must not be overlooked if the structure is to withstand successfully the effects of Fire, Water, Earthquake, Impact of falling building members and building contents such as Safes, Machinery and other heavy objects. Last but not least is the protection against mob rule caused by political disturbances or other uprisings which will permit a mass attack without interference. Vault Walls, Vault Doors and Steel Linings are the principal factors of protection from any of the above mentioned possibilities. The walls and Vault Doors must be equal in strength to resist attack from any source, individually or collectively.

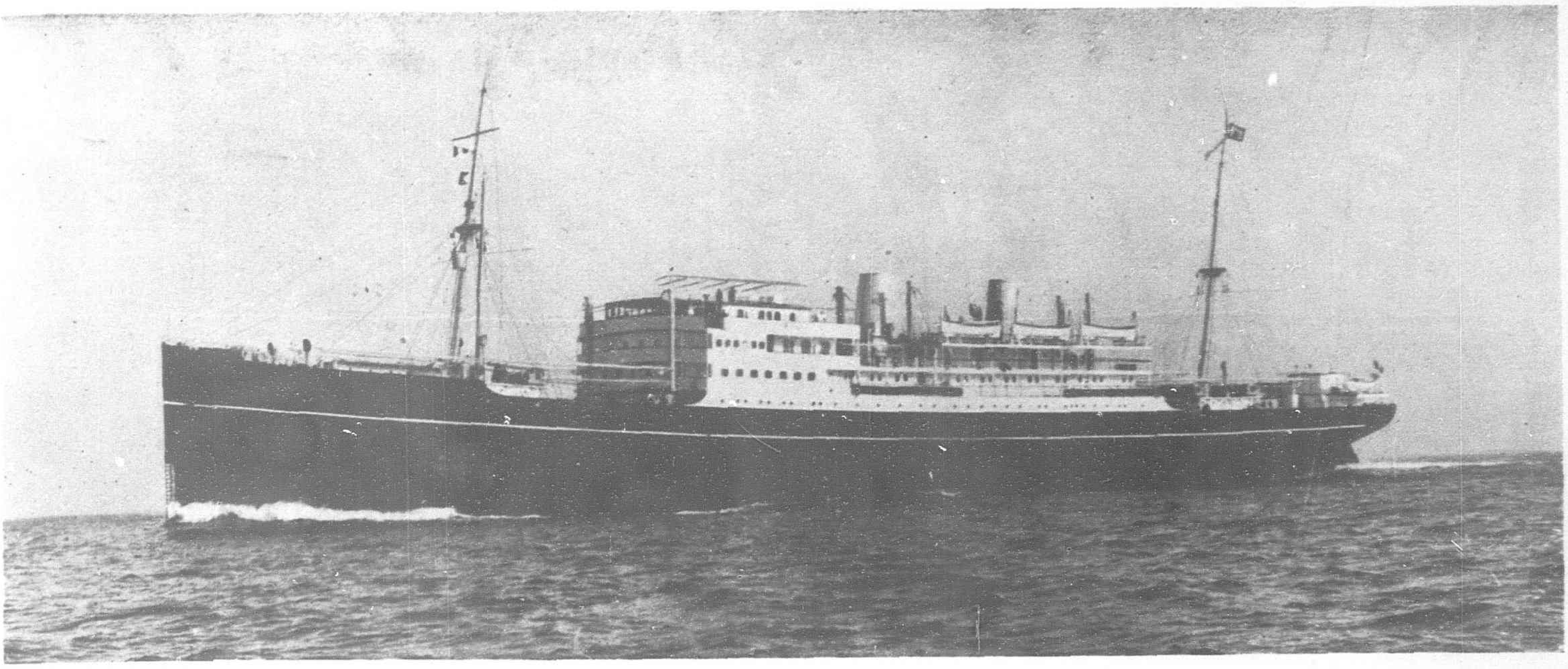
Burglar or mob proof construction as considered by the York Safe and Lock Co. is a matter of applying science to combat the destructiveness of science. We cannot dispute the acuteness of the modern burglar's mind that is constantly busy in inventing new tools and appliances to combat new metals and devices used by up to date vault and safe builders.

The burglar had practically his own way until a few years ago when the York Safe & Lock Co. after exhaustive experiments and tests perfected a highly refractory alloy known as Infusite a non-burnable metal that has successfully resisted 6,000 degrees fahrenheit the most intense heat ever developed by an exyaccetylene torch. This metal which has baffled any attempt at penetration is now being incorporated in all vault doors built by the above Company. This can also be incorporated into interior steel linings.

Looking forward to a time when some genius may possibly invent a heat that will penetrate Infusite. Other protective measures have been taken in perfecting a plate known as Hard Chemical Compound which when brought into contact with heat throws off volumes of smoke and intense tear gas that will compel the intruders to retreat. Two of the largest vaults in the world now being constructed for the Irving Trust Company and the Bank of Manhattan in New York City embody both the above protective features in their entire vault construction.

Competition in banking to-day is becoming so keen that the Bankers must be more confidential with his customers in personal contact, high partitions and private offices to-day are a thing of

(*Continued on page 270*).

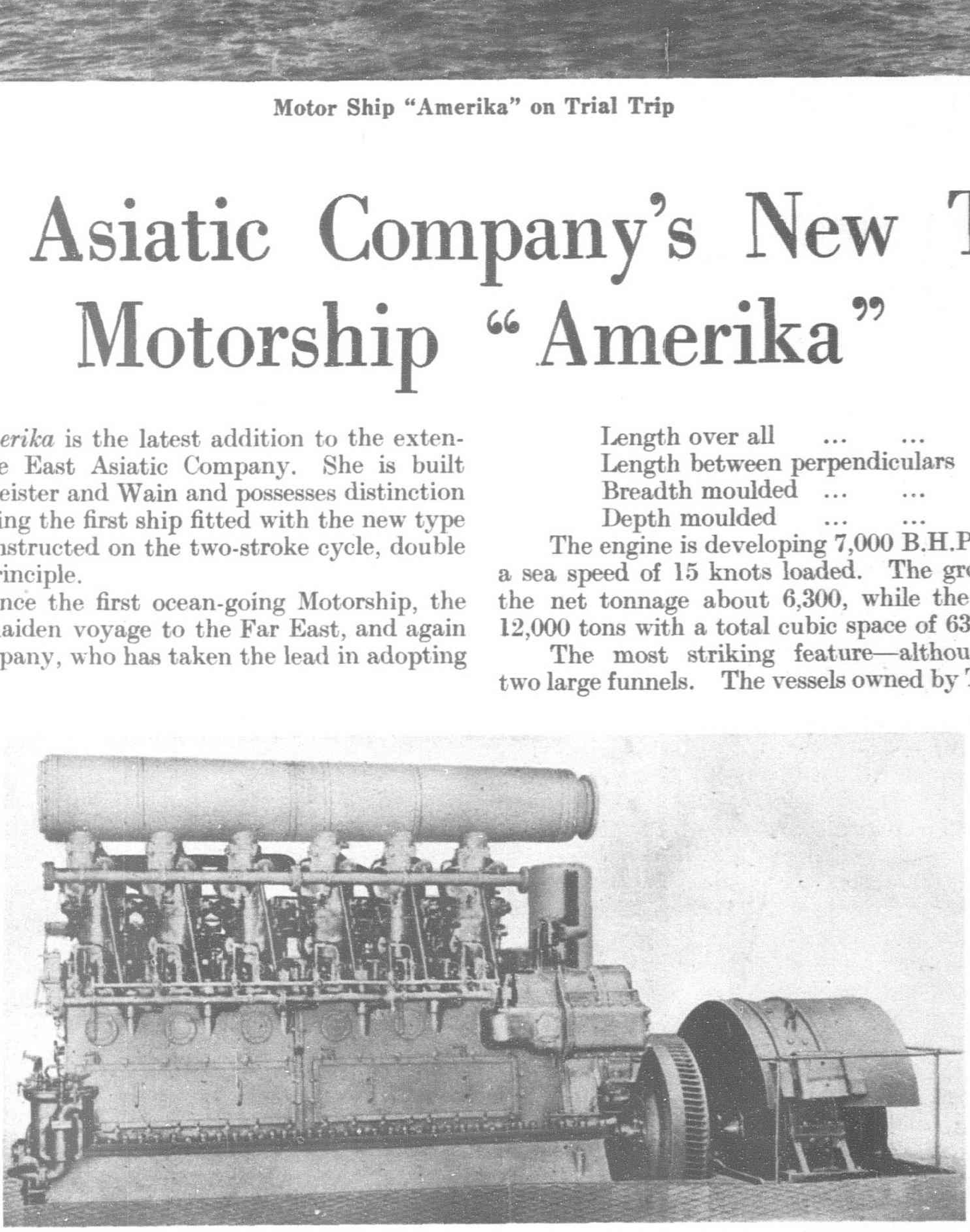


Motor Ship "Amerika" on Trial Trip

East Asiatic Company's New Type Motorship "Amerika"

The motorship *Amerika* is the latest addition to the extensive fleet of The East Asiatic Company. She is built by Messrs. Burmeister and Wain and possesses distinction on account of being the first ship fitted with the new type of the B. & W. engine, constructed on the two-stroke cycle, double acting, airless injection principle.

It is now 18 years since the first ocean-going Motorship, the *Selandia* started on her maiden voyage to the Far East, and again it is The East Asiatic Company, who has taken the lead in adopting this new type.



600 B.H.P. Single Acting 2 Cycle Burmeister & Wain Diesel Generator Engine of M.S. "Amerika"

The *Amerika* which now has undergone a series of successful trials will be watched all over the world with great interet, and the East Asiatic Company is thus gaining great honour in assisting the Danish colors to introduce this new creation.

It is, however, not merely the propelling machinery which will draw attention, but the ship itself is highly attractive and interesting, being one of the world's largest ships of the single screw type, built as a combined passenger and cargo vessel with splendid and unique accommodation for 52 first class passengers.

She is particularly adapted to the Pacific trade, built as a complete superstructure vessel to the highest class in British Lloyd's.

The vessel is rigged with two masts, having a straight stem and eliptical stern.

The principal dimensions are the following :

Length over all	484-ft.—3-in.
Length between perpendiculars ...	465-ft.—0-in.
Breadth moulded	62-ft.—0-in.
Depth moulded	40-ft.—0-in.

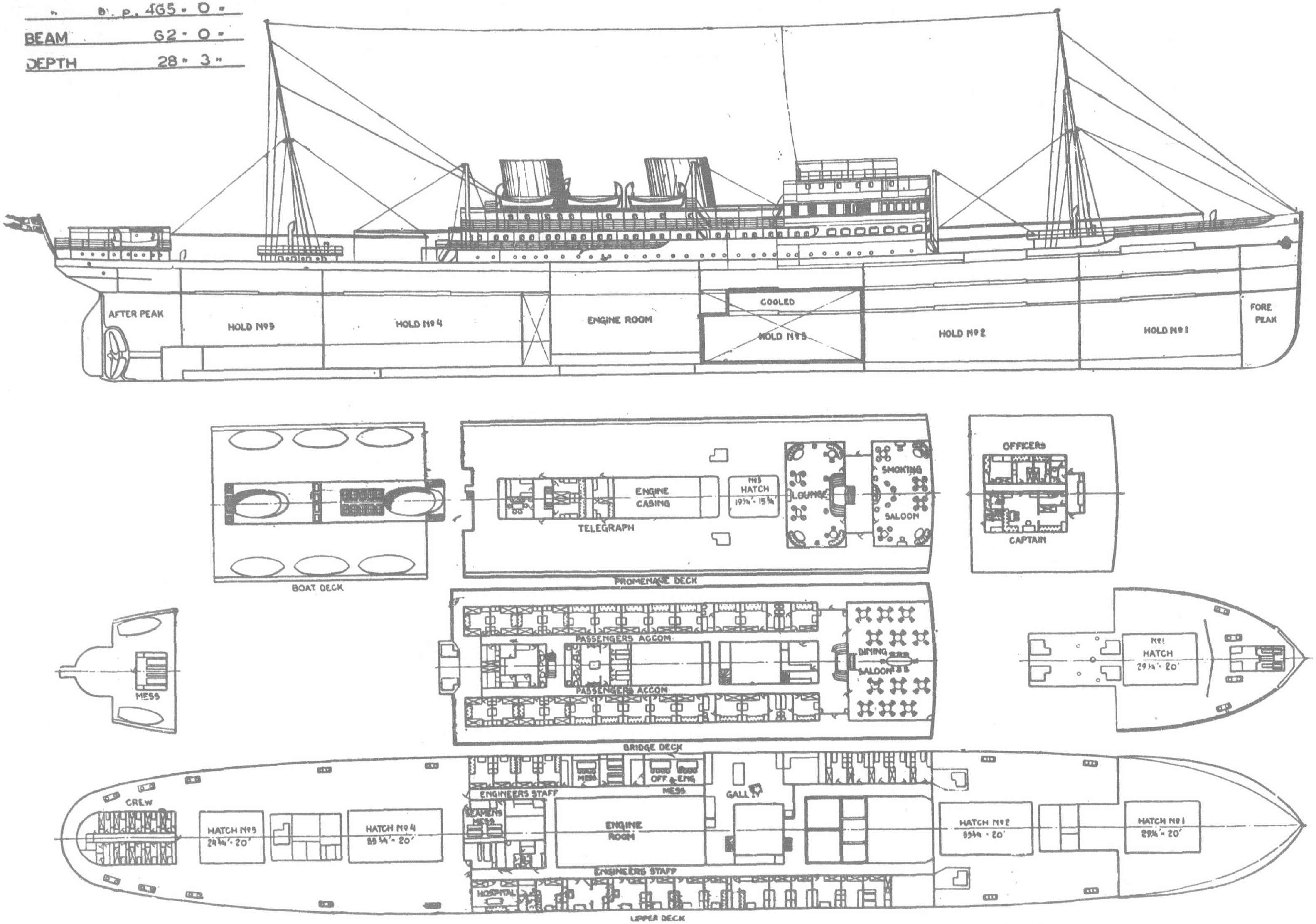
The engine is developing 7,000 B.H.P., and the vessel will have a sea speed of 15 knots loaded. The gross tonnage is 10,100 and the net tonnage about 6,300, while the dead weight capacity is 12,000 tons with a total cubic space of 630,000 cub ft. bales.

The most striking feature—although a motorship—is the two large funnels. The vessels owned by The East Asiatic Company are popularly called "The non-funnel fleet," but in this addition, which is intended to open up a new route, the Company has also found it opportune to let the appearance of the ship depart from the old standard type.

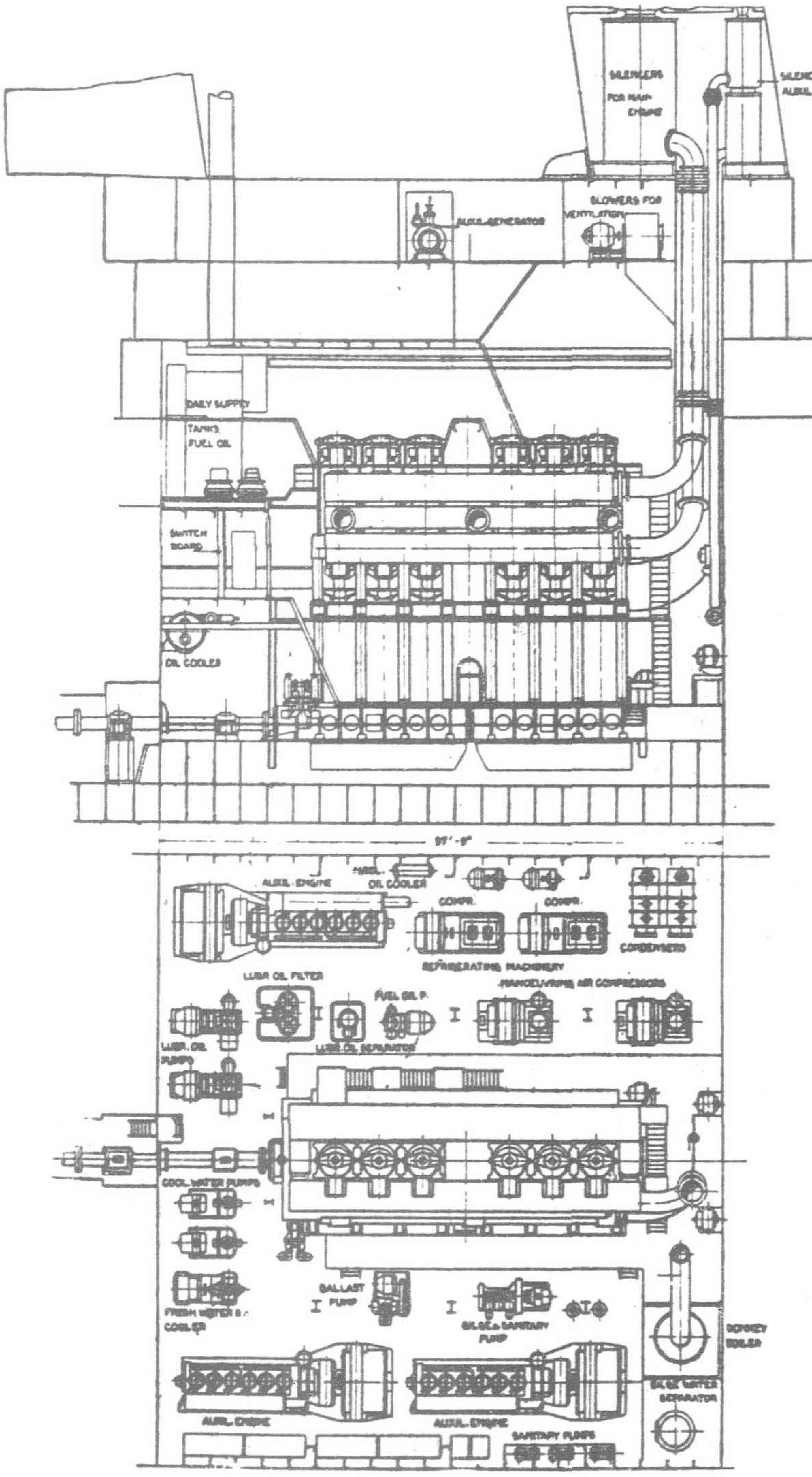
The forward funnel is utilized for the silencers for the main engine as well as the auxiliary engines, whilst the after funnel is a dummy containing water tanks and electric motors for working the mechanical ventilation plant for the passenger accommodation.

The upper deck carries a long bridge for the accommodation of the officers etc., space for provisions and the galley as well as a long forecastle extending to the winch house arranged around the fore mast.

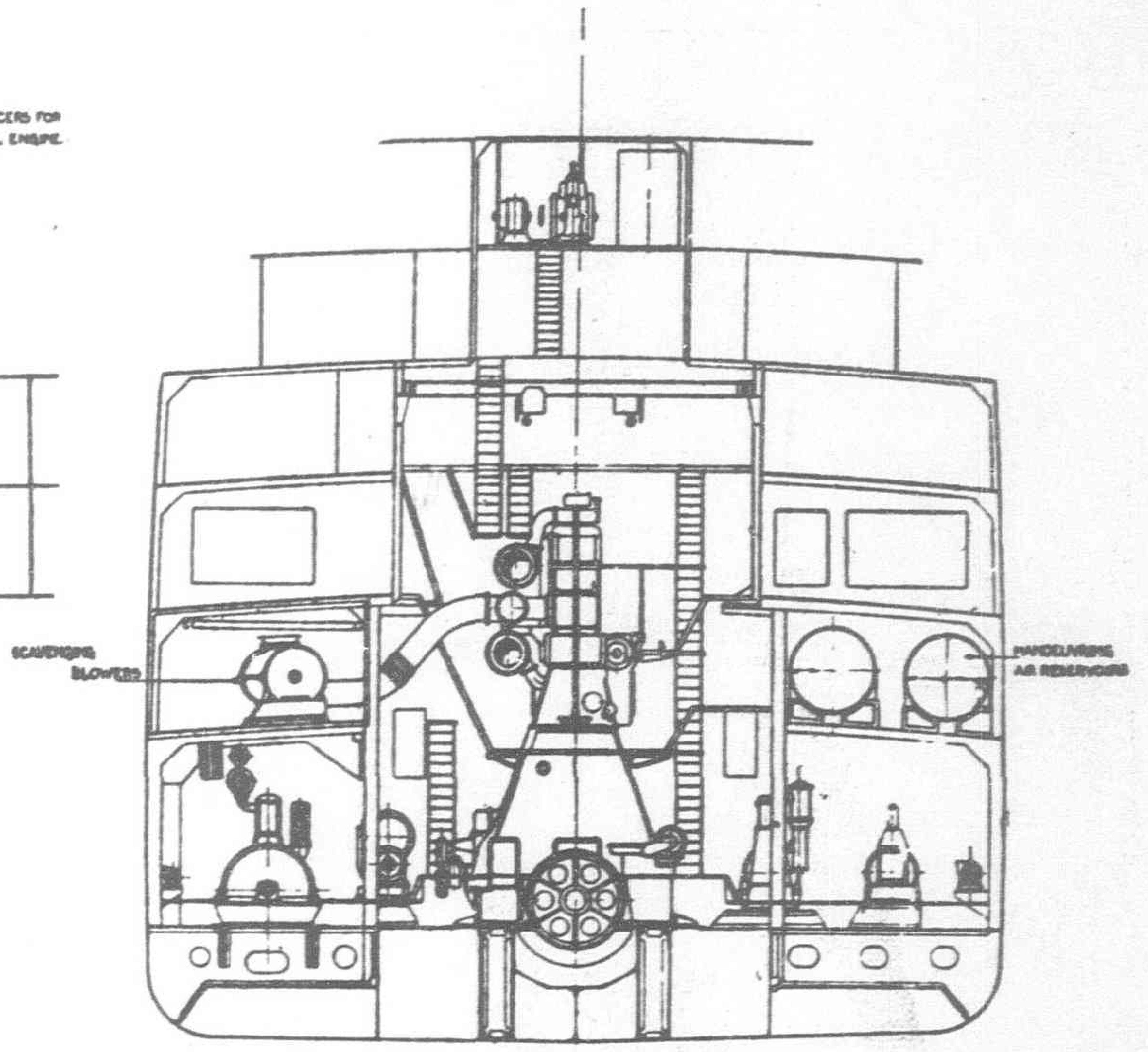
The vessel is fitted throughout with double bottom which is sub-divided by seven watertight divisions into six tanks, capable of



Motor Ship "Amerika": Length O.A., 484-ft. 6-in.; B.P., 465-ft.; Beam, 62-ft.; Depth, 28-ft. 3-in.



Engine Room Arrangement,



carrying together with the wing tanks at the tunnel side 1,800 tons of fuel oil. The fore and after peaks are ample and arranged for water ballast or fresh water. Abaft the engine room is a deep tank for water ballast and in this way the total water capacity aggregates 2,800 tons.

The ship is sub-divided by seven watertight bulkheads into six spaces, where number four is the engine room so that three of the cargo holds are forward and two abaft the engine space. No. 3 hold is arranged for refrigerated cargo with a total capacity of 70,000 cub. ft. This hold is intended for fruit and special measures are taken in view of carrying bananas.

The cooling installation is of the latest type, on the principle blowing in air, the current of which can be altered in the most effective way according to requirements and distance thermometres for observing the temperature in the various quarters are fitted. Forward of the engine room, the ship is provided with a 'tween deck so that the height of the cargo hold does not become too large.

Five hatches measuring up to 36 ft. in length gives access to the holds. No. 1 hatchway is carried up to the forecastle deck and No. 3 is a trunk extending from the main deck to the promenade deck.

The rigging and cargo appliances are of the most modern and efficient type to facilitate rapid handling of the cargo, to suit the exacting conditions of loading and discharging in the ports, the ship is destined to visit.

The winch houses are built around the masts, and that at the foremast is arranged to store lamps, searchlights, paints and boatswain's gear, whilst the after one around the main mast contains washing and laundry machines as well as cargo office and store rooms.

The largest of the holds, No. 2 and 4, are each served by four derricks—two 3-tons and two 5-tons whilst the remainder are fitted with two 5-tons derricks each. In addition, number 2 hatch is provided with a 30-ton derrick for handling heavy weights.

All the winches are electrically driven of Thomas B. Thrige's make.

The vessel is provided with a wide range of sun shade awnings, particularly, above all living rooms, which for the passengers are located in houses above the bridge deck.

There are in all 24 staterooms to accommodate 48 passengers in the house on the bridge deck, and two staterooms for four passengers in a house on the promenade deck.

All staterooms are very spacious and airy, fitted out with great comfort. Six of the rooms have separate bath rooms comprising a built-up tiled bath, wash stands and lavatory. For the use of the other passengers accommodated in this house there is a number of bathrooms for ladies and gentlemen containing wash stands and lavatories. All staterooms without separate bathrooms are fitted with two washstands with running hot and cold water.

18 staterooms are provided with one nickled brass cot bed and one sofa berth so that they may be used for one or two according to requirements. The remainder of the rooms are fitted with two nickled cot beds and one sofa. There are two wardrobes to each room, decorated to match the color of the walls, and all the wardrobe doors are fitted with a mirror in full height on the back.

The dining saloon, located on the bridge deck forward of the staterooms, is very spacious and all the wood work is done up in a very minute and tasteful manner.

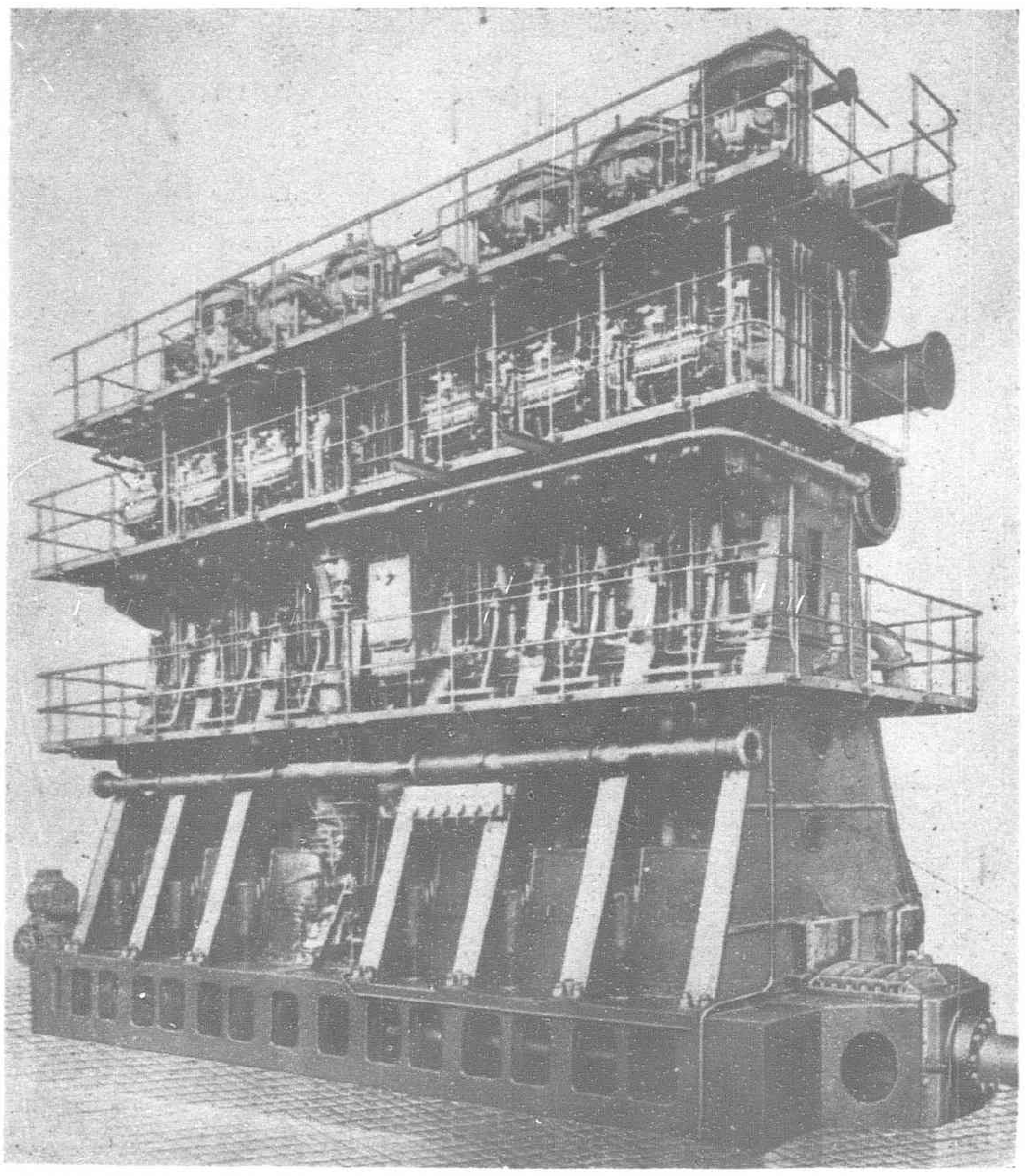
Description of Propelling Machinery for M.S. "Amerika."

Turning to the propelling machinery of the M.S. *Amerika*, this represents a new technical development in so far as it introduces the new Burmeister and Wain two-stroke cycle double-acting type of Diesel engine.

MAIN ENGINE

The vessel is equipped with one Burmeister and Wain two-stroke cycle double-acting Diesel engine, capable of developing about 7,000 B.H.P. on one shaft at about 95 R.P.M.

The engine is of the enclosed forced lubricated type using solid injection for the combustion of the fuel oil. It is provided with separate electrically driven scavenging air pumps of the special



7,000 B.H.P. Double Acting Burmeister & Wain Two Cycle Main Diesel Engine of M.S. "Amerika"

B. & W. enclosed rotating type, running perfectly reliable and noiseless.

The thrust bearing is of the Burmeister and Wain Plain one collar forced lubricated type fitted direct on the engine and incorporated in same, this being Burmeister and Wain's Standard practice for smaller engines, which is now for the first time used in connection with a machinery of this size.

DETAILS OF CONSTRUCTION

The double-acting Diesel engine of the two-stroke cycle principle *for the propulsion of large ocean-going ships as designed by Burmeister and Wain is the latest type of two-stroke engines on the market*, resembling closely the firm's type of four-stroke double-acting engine, embodying the following important features in the design :

SCAVENGING AND CYLINDER LINER DESIGN

The scavenging ports are common for top and bottom, arranged in a single row right around the circumference of the cylinder liner in the center above the top of the piston in bottom position, and below the bottom of the piston in top-position.

The cylinder liners are in two parts—a short upper and a longer bottom part, the scavenging ports being arranged in the latter.

The top and bottom parts are each provided with a flange for bolting to the cylinder cover.

The cylinder liners are secured by means of four stay bolts for each cylinder, passing from the top cover to the underside of the cross girder of the bed plate. The jointing surface of the cylinder end requires to be tight only for the low presure at the end of the expansion and to the atmosphere. The jacket for the admission of the scavenging air in the center of the cylinder liner has a loose part, extended downwards forming a cylindrical cooling jacket around the bottom cylinder liner. The top cylinder liner is surrounded by a single cylindrical cooling jacket bolted to the underside of the top cover.

COVERS

The top and bottom cylinder covers are almost alike. They consist of an inside cylindrical extension of the cylinder liner, completed by an arched bottom and placed inside of the outside square body of the cover. The bottom covers are bolted together in groups. the top covers being separate. The internal part of the covers is in the center provided with a cylinder for the exhaust piston valve, having the exhaust ports arranged around the whole of its circumference, and surrounded by water cooled jackets for connection to the exhaust manifolds. The direction of the current of scavenging air as indicated by the arrow assures in the most simple way an effective scavenging of the bottom cylinder.

EXHAUST PISTON VALVE

The exhaust piston valve for the top cover is simply a hollow piston fitted with self-expanding Perlit piston rings, and arranged for oil cooling internally.

The piston valve for the bottom is also of the plain piston type provided in the center with a large boring for the piston rod and fitted internally as well as externally with self-expanding pistonrings.

The hollow space is oil cooled in the same way as the top piston valve, the oil being taken from the forced lubrication system and admitted by means of telescopic pipes.

PISTONS

The pistons are of a similar design to that of the pistons of B. & W.'s double-acting four-stroke engines, but longer, like all pistons for the two-stroke types, *viz.*, the length of stroke minus the height of the scavenging port. They are nevertheless shorter than for the most of the types of double-acting two-stroke engines, owing to the adoption of only one row of scavenging ports and the elimination of exhaust ports.

The piston halves of Perlit are bolted around the piston rod flange ; the bottom half is extended forming a cylindrical liner surrounding the piston rod in the whole length.

The pistons are oil cooled, and the oil admitted by means of telescopic pipes to the annular space between the piston rod and the liner, being led away through the central hole bored in the piston rod.

The Characteristic Advantages in the Design of Cylinders and Piston Valve

It will be apparent that, as a whole, the construction of these main parts of the engine, the moving as well as the stationary parts subjected to heat stresses, are the same as that of the B. & W. four-cycle engine, *viz.* cylinders, pistons and piston rings, the design of which is very simple and without complications.

The effective scavenging in connection with the fact that the parts most exposed to the hot combustion gases are reduced to about one half the size of the cylinder are some of the great advantages of this system.

Further, the stroke of the piston valve passing the ports is only about one-third of the piston stroke with a correspondingly smaller speed.

The top and bottom exhaust piston valves are rigidly connected by means of crossheads and links. They have no moving parts requiring lubrication outside the crank case.

All the moving parts are inside the crank case. They consist of balancing levers and connecting rods driven from a smaller crank shaft arranged in the bed plate parallel to the crank shaft and connected to this by means of a chain drive.

The whole mode of procedure in controlling the exhaust resembles much that of the ordinary piston valve gear for steam engines, but with one very important difference. While the steam piston valve renders a certain resistance, owing to friction, thus reducing the mechanical efficiency of the engine, the exhaust piston valve of the B. & W. double-acting two-stroke engine is developing useful work. On account of having a suitable angle of lead for the exhaust piston valve gearing, the mean pressure acting on the valve will be high.

The piston valve gear will increase the horsepower of the B. & W. double-acting two-stroke engine with about 10 per cent. above that developed by the main piston.

THE COMBUSTION

The B. & W. type of double-acting two-stroke Diesel engine is fitted with airless injection on exactly the same principle and make as fitted for the four-stroke type.

The automatic fuel valves are fitted in each cylinder end diametrically opposite to each other. Each cylinder end is thus provided with two spraying nozzles. Each nozzle injects the fuel in a fan-shaped spray extending over a horizontal plane. In order to clear the piston rod and the cylinder wall the directional axis of the sprays is set to form an angle of approximately 45° with the connecting diameter of the two nozzles. The path of the sprays of atomized fuel are slightly curved, carrying the fuel along through the combustion space, on account of a moderate whirling motion of the body of the combustion air due to the tangentially disposed scavenging ports.

Diesel Auxiliaries

Diesel Generators.—There are three auxiliary 6-cylinder B. & W. Diesel engines built as single acting trunk piston two-stroke cycle engines with direct driven rotating scavenging pump and airless injection. They are arranged in a way that they can work separately or totally independent of the main engine and its auxiliaries. They are constructed for an output of each 600 S.H.P. at 300 R.P.M., and direct coupled to 220 volts dynamos, having a capacity of 365 KW. Of these one or two will be needed at sea according to circumstances. Consequently a total of about 1,100 KW. will be available for supplying the current for operating the auxiliary machinery for lighting purposes fans, wireless etc.

Special precautions have been taken to eliminate vibrations from the hull, and the Diesel generators as well as the main propelling engine have been fully balanced.

AUXILIARIES

There are two sets of main cooling water pumps of the centrifugal type, each direct coupled to an electric motor, to give sufficient cooling water for main and auxiliary engines. The pumps are amply dimensioned so that only one will be needed, one acting as stand-by.

In addition a separate electric motor driven cooling water pump for the auxiliary engines is fitted for use in port.

The lubricating oil pumps are of the B. & W. special design rotary type, driven by electric motors, each designed for a capacity of about 200 tons per hour. To cool down the lubricating oil, there is one 150 sq. metres cooler of the condenser type. An oil separator is fitted in the lubricating oil circuit, driven by an electric motor.

The oil fuel supply pump has a capacity of 50 cubic meters per hour and is driven by an electric motor.

The ballast pump is a rotary pump coupled to an electric motor and the capacity is 150 tons water per hour.

One set of pumps are installed acting as bilge and sanitary pumps and consisting of two bilge and one sanitary pump of the single acting plunger type.

In the engine room a cross tube boiler is installed as heating and auxiliary boiler, with a heating surface of about 120 sq. ft. and designed for 80 lbs. working pressure. Oil firing is fitted and burners of B. & W.'s special type are used.

For starting and manoeuvring of the main engine there are two two-stage compressors of the B. & W. type, each compressor being operated by an electricmotor.

Actual Weights of Machinery

A very low machinery weight has been obtained, the figures being as follows:

	Tons.
Main engine	360
Diesel Generators	75
Scavenging blowers and auxiliaries for Diesel plant	75
Reservoirs, silencers, spares and tools, auxiliaries for ships use, etc., Inventory, Workshops etc.	108
Shafting	100
Boilerplant	8
Electrical equipment for engine room, floors, ladders, etc. Piping	120
Total	846 Tons.

giving a weight for the complete installation of 120 kilos per B.H.P., or *51.5 kilos per B.H.P. of the main engine.*

Compared to the double acting 4-stroke B. & W. type as installed in the *Chichibu Maru* the new double acting 2-stroke type of the *Amerika* means a progress in economy of fuel oil of about 10 per cent. but this is partly due to the fact that the engine of the *Amerika* is fitted with B. & W.'s new airless injection system of fuel oil. This system also has the advantage of being easily adaptable for burning all grades of American oil. Difficulties with the use of different kinds of oil have so far been an obstacle for the introduction with ocean-going ships of various existing systems of airless injection while the B. & W. system already has proven very satisfactory in many ships built in the last couple of years, for instance also some Japanese ships fitted with single acting B. & W. Diesel engines.

Most amazing is, however, the fact that a ship of M/S *Chichibu Maru's* size and power would obtain a saving in engine room dimensions of about 30 per cent. and a saving in engine weight of about 50 per cent. if fitted with engines of the same type and cylinder dimensions as used in the *Amerika* instead of these actually installed. The same saving could of course approximately also be effected as regards the *Asama* and *Tatsuta Maru.*

It is necessary to add that, this comparison is not a reflection on the choice of N.Y.K. in selecting nachinery for their three new trans-Pacific liners. At the time these vessels were planned, such engine plants as selected were the only large marine Diesel plants for which there then was sufficient service records to warrant their use. The comparisons merely go to show the progress of Diesel engine development to-day.

The Trial Trip

The ship left the berth at 9 a.m. on January 21, to start the trials which took place in the Sound near Copenhagen, and were finished somewhat after 6 p.m.

As an average of the runs on the mile, a speed of 16.55 knots was obtained, the corresponding power of the engine being 7,670 B.H.P. or 8,613 I.H.P. at 111 R.P.M.

During the consumption test of six hours duration, the main engine developed 7,300 I.H.P. or 6,450 B.H.P., giving a fuel oil consumption of 166.5 grams or about 0.365 lbs. per B.H.P. hour for all purposes. According to experience, the efficiency of the engine, fully run-in, during actual service, will increase about 4 per cent. so that the fuel oil consumption will correspondingly be about 0.35 lbs. per B.H.P. hour.

The manoeuvring tests which were carried out before the trials were finished, showed very easy starting ahead and astern, the engine running quietly up to the speed without overstepping the mark.

There were no vibration of the main engine at all even at the maximal speed and movement could scarcely be felt, although the vessel was light.

In the trial which was a complete success in every respect participated representatives for the Owners, the Builders and the classification Society, besides a large number of guests from the most prominent companies, including the Blue Funnel Line, The United Steamship Co., The Swedish American Line, The Norwegian American Line, The Bergen S. S. Co., and The Linea Sud America.

The ship left Copenhagen on January 23 to start her maiden voyage, preliminary to Bangkok.

Public Construction in Canton

(Continued from page 219).

Before Shanghai was open to foreign trade, Canton was the only trading port to which early western traders were given access. When to-day, however, large steamers come to ply along the coast of China, Canton offers no facilities to accommodate them, although Canton is actually the second largest Chinese port. In 1928 total import through the Port of Canton amounted to 44,000,000 Haikwan taels, (excluding import of Chinese products, which alone amounted to 62,995,762 Hk. Tls.). The total tonnage of ships entered and cleared 7,570,000 tons, the average daily tonnage entered and cleared 20,000 tons. Such a volume of trade necessitates the construction of a modern port. With this in view, the Canton Municipal Government has projected plans for the erection of municipal wharves along the bank of the lower reach of the Chukiang or Pearl River, near the vicinity of Pak Ngao Tam, on the western part of Honan Island. This section of the Pearl River being the deepest and widest in the neighborhood of Canton, is the most suitable site for an up-to-date harbor capable of accommodating large steam vessels. At present only vessels of two thousand tons or under can be accommodated. In Dr. Sun Yat-sen's scheme for the development of Whampoa, which by the way is an integral part of the projected City of Greater Canton, harbor improvement was emphasized. When this scheme is carried out Canton will become one of the finest ports in the world and will be able to capture part of the trade which is now concentrated in Hongkong.

Mechanical Coal Loading and Handling in the Ports of Japan

The following article is extracted from a paper read before the World Power Conference at Tokyo by Mr. K. Nanjo, Director of Mitsui Bussan Kaisha, which covered the entire problem of transportation and distribution of coal in Japan. This is the most informative compilation on the mining and movement of coal in Japan that has appeared in print, but owing to its great length we have extracted those parts that have a direct interest to shipping concerns and manufacturers of coal handling appliances.

DUE to various reasons most of the harbors of Japan are devoid of bulk loading equipment. Especially is it true where shipments are in small quantities; but the economic value of mechancial loading is being gradually recognized.

In the Kyushu district mechanical equipment was first introduced at Wakamatsu in 1898, and at Miike in 1909, where later additions and improvements have brought the loading facilities sufficiently adequate for the present needs. In Hokkaido, both at Otaru and Muroran harbors, large coaling piers were built in 1912, in order to facilitate bulk shipments by steamers. At other ports, the mechanical equipment is of comparatively smaller scale.

Loading Methods

A brief description of the mechanical equipment installed at Wakamatsu, Miike, Otaru, Muroran, and Moji is given herewith. There is no mechanical equipment worth mentioning at other ports.

(A) WAKAMATSU HARBOR.

(1) AREA:

Outer harbor	10,436,000 tsubo
Main harbor	240,463 „
Inner harbor	3,078,541 „

(2) HARBOR EQUIPMENT:

Breakwater (length)	8,142 feet
No. of Mooring buoys	14 „
Loading quay:	
For steamship use (length)	2,394 feet
For steamship use (depth of water)	20 „
For schooner use (length)	1,800 „
For schooner use (depth of water)	6 „

(3) LOADING EQUIPMENT:

No. Hoists (Tobata side)	3
No. Hoists (Wakamatsu side)	1
No. Loading cranes (Wakamatsu side)	1
Loading pier (Wakamatsu side)	3,236 feet

(4) STORAGE:

Area	278,941 tsubo

MANUAL LOADING

(5) LOADING METHOD:—There are two methods of loading employed at this port, which may be taken as a standard practice throughout the country where manual loading is used. One method is that a bamboo or cane basket loaded with about one ton of coal is hoisted by the ship's winch from the lighter (Fig. 4). This coal is emptied on the deck of the steamship, whence it is either scooped into the bunker hold or carried by coolies on their shoulders by means of smaller baskets. The other method of loadings is that series of steps are made on the side of the ship by means of narrow boards and ropes, appropriate struts being tied on against the side of the ship, so as to give a proper slope for the steps. On each of these steps stand one or two men, more often women, who pass on small baskets containing coal which have been filled from the lighter (Fig. 5). The baskets, on reaching the top or gunwale, are slid on a narrow sliding board to the hatch where they are emptied into the hold, the empty baskets being thrown back to the lighter. The coal is then scooped and trimmed to suit the condition. In either method about twenty-five hands are necessary, and the loading speed is about twenty tons per unit equipment per hour.

The former method is very often used when loading ships whether for bunker fuel purpose or freight shipment; the latter

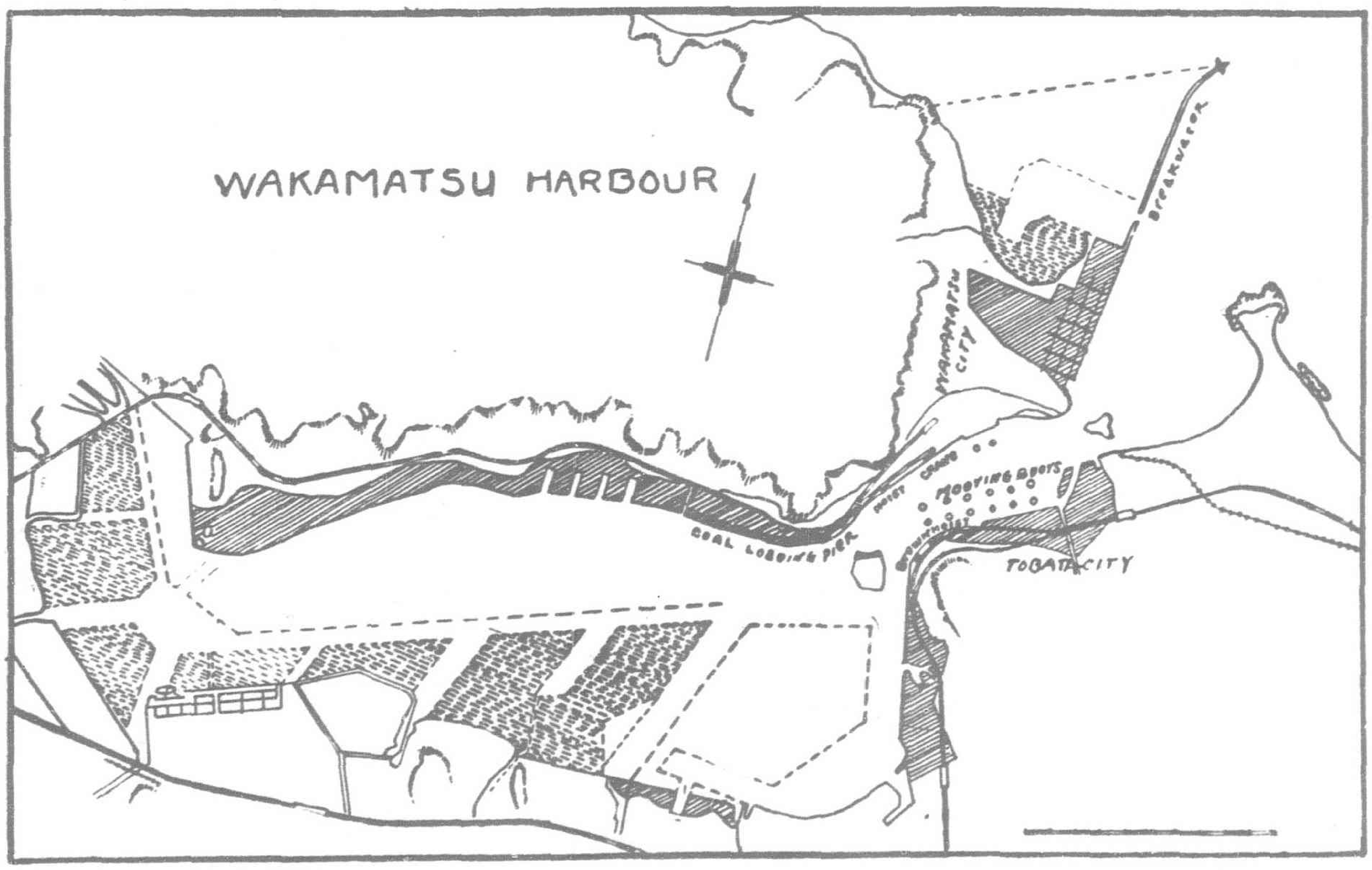
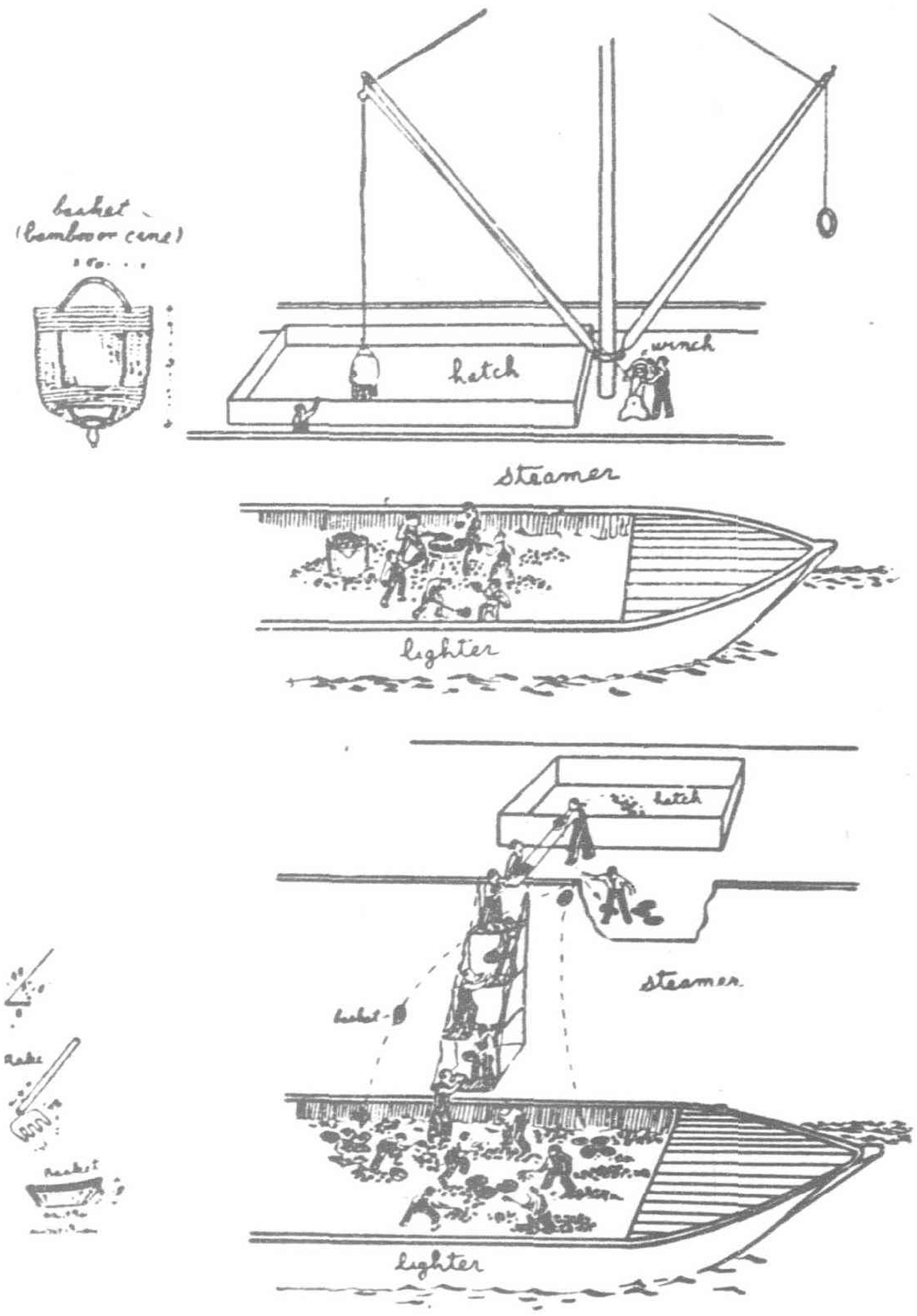


Fig. 3.—Wakamatsu Harbor



Figs. 4 and 5.
Manual Loading.

method is used only when loading is for bunker purpose. The loading speed in the first case is about sixty tons per hour. When the ship lays alongside a quay; a walking plank is placed from the quay to the ship, on which coolies carry on their backs, baskets, containing about one hundred pounds of coal. The coal is carried to the hatch and emptied into the hold, and then scooped and trimmed as before. The loading speed in this case is about fifty tons per hour. Sailing schooners are treated in a similar manner, where the loading speed is about forty tons per hour.

MECHANICAL LOADING

A brief description of the mechanical equipment at Wakamatsu, including Tobata, and its working conditions will be given below. The machinery and appliances, excepting minor equipment owned privately, are let out to the carriers by the Imperial Government Railways.

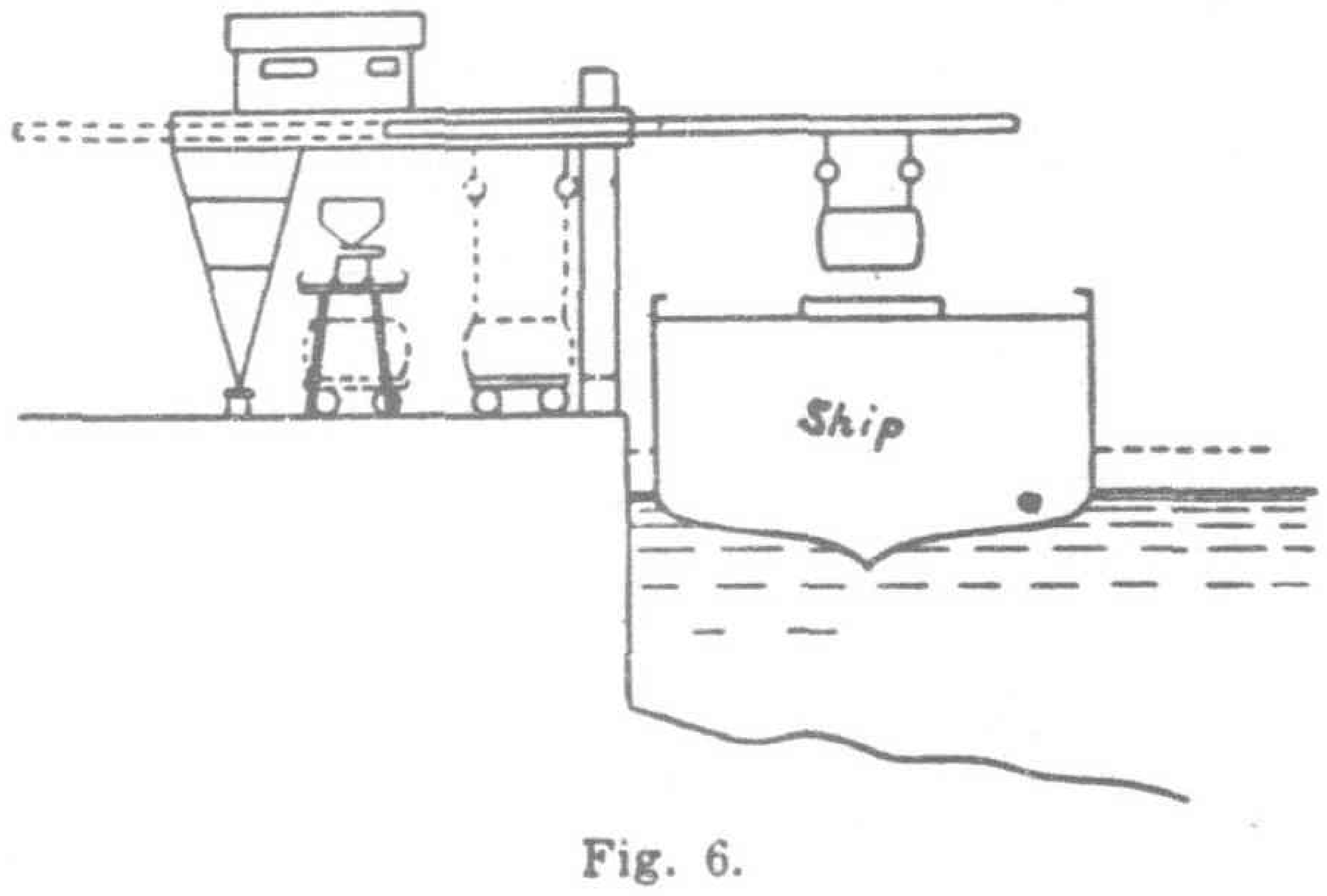


Fig. 6.
Diagrammatic sketch of Brownhoists at Wakamatsu.

At Tobata side, there are three sets of Brownhoists (Fig. 6) which have a combined loading capacity of 6,700 tons per day, each having a working speed estimated at one coal wagon for every 95 seconds.

At Wakamatsu, there is one hoist (Fig. 7) and one crane (Fig. 8).

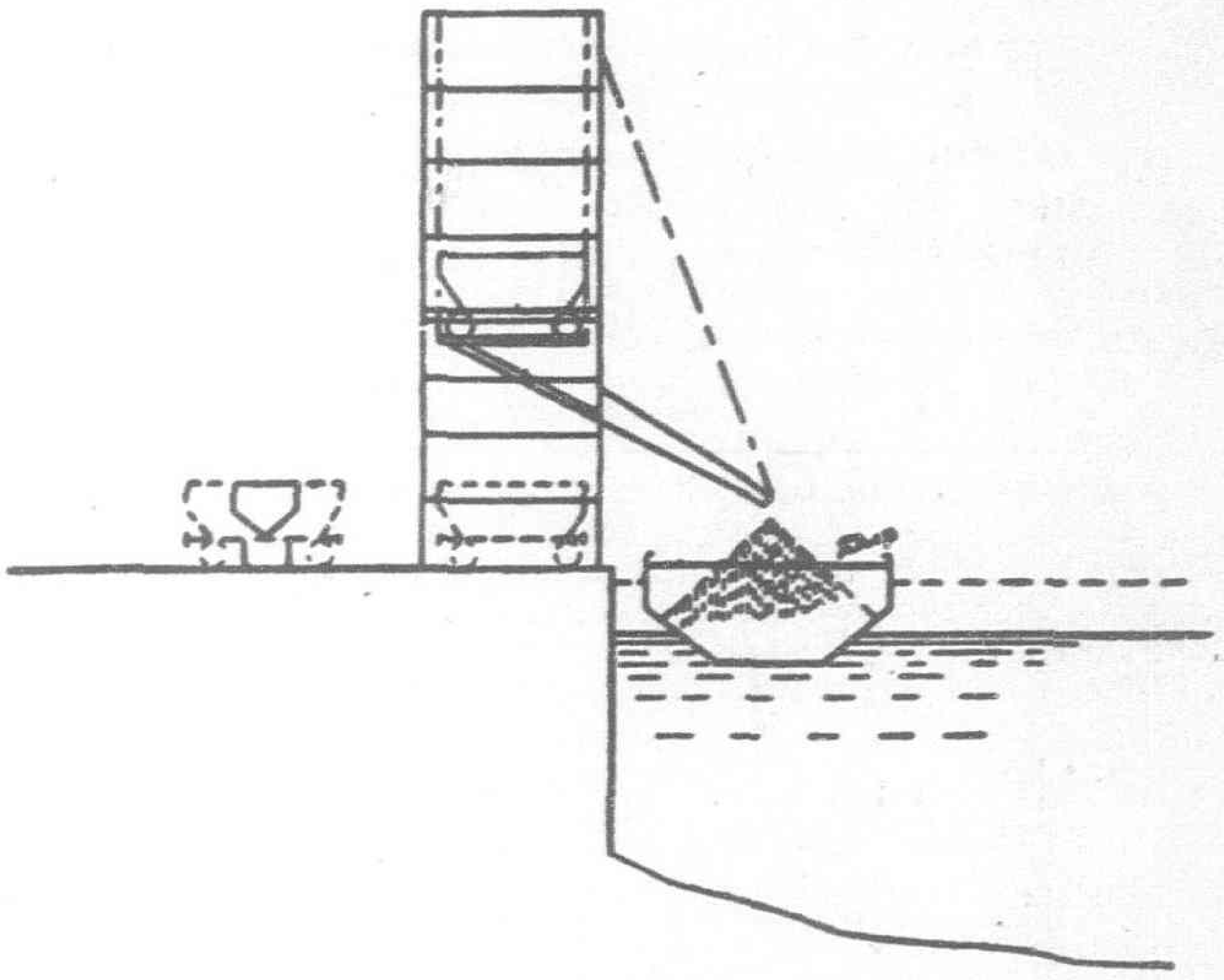


Fig. 7.
Diagrammatic sketch of hoist used at Wakamatsu.

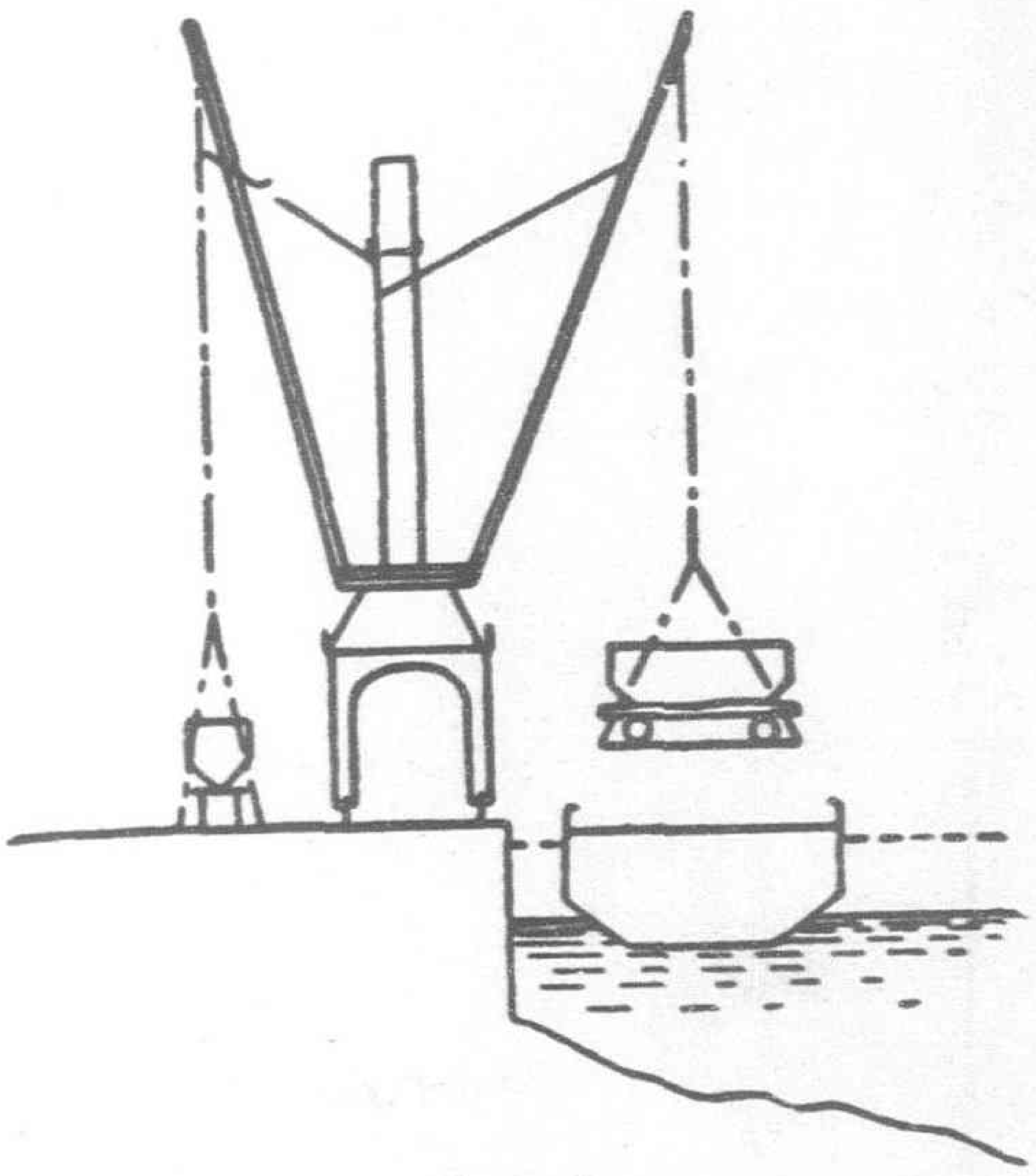


Fig. 8
Diagrammatic sketch of crane used at Wakamatsu.

In addition to the above there is in use a coal loading pier (Fig. 9) which is 2,236 feet long, 19 feet high and 40 feet wide, equipped with 17 loading chutes. Its loading capacity is 18,000 tons per day.

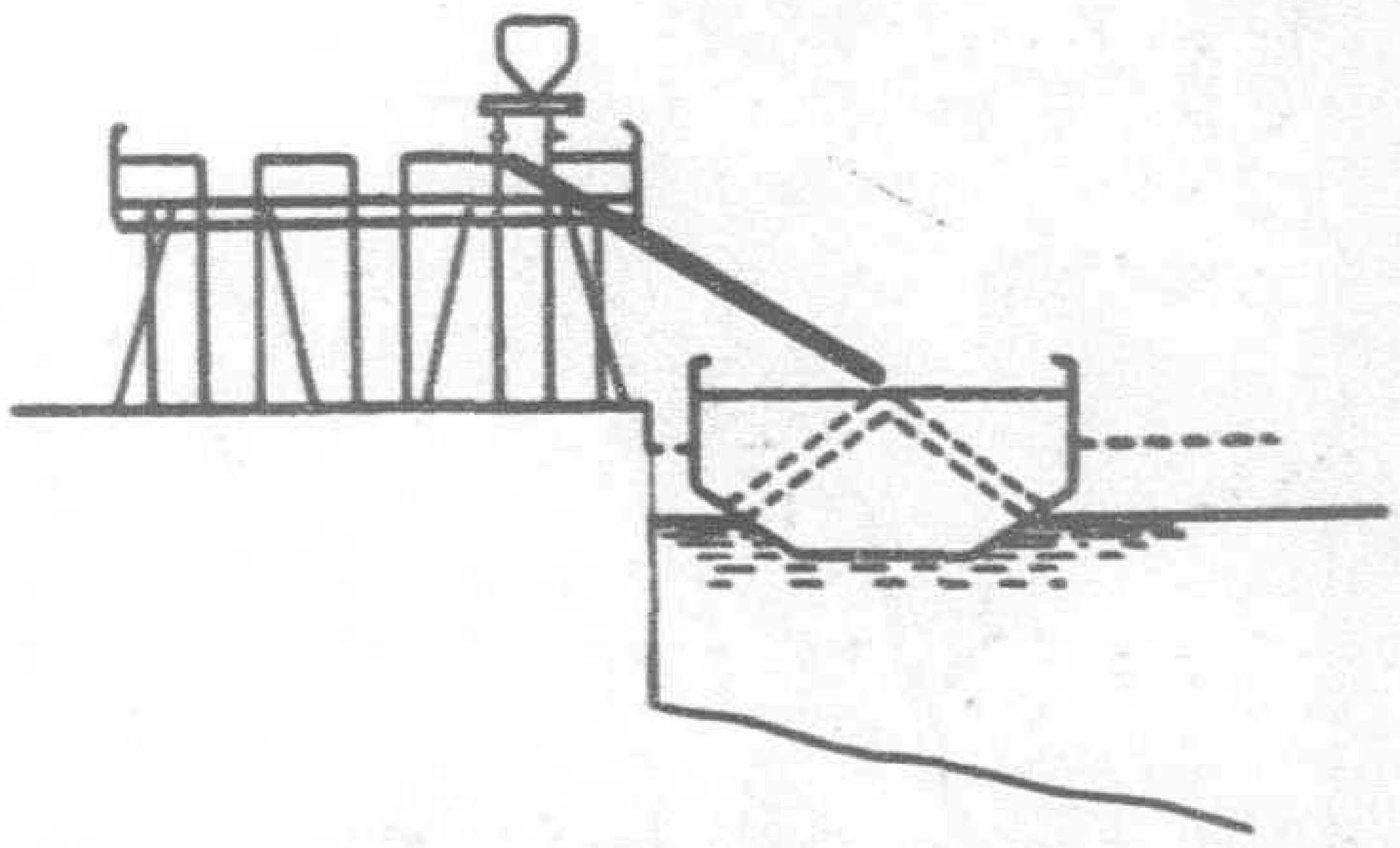


Fig. 9.
Diagrammatic sketch of loading pier at Wakamatsu.

	Lifting power in tons	Time for loading one coal wagon in min.	Loading capacity in tons per day
Hoist ..	35 tons	2	4,300
Crane ..	27 ,,	1½	4,300

During 1927 the amount of loading at the Port of Wakamatsu was as shown in the following Table.

Table VII.

Place	Loading method	Steamship loading (tons)	Native vessel loading (tons)	Total (tons)
Tobata side ..	Brownhoists ..	1,704,000	528,000	2,232,000
Wakamatsu side ..	Coal pier ..	—	4,035,000	5,702,000
,, ,, ..	Hoist	—	1,053,000	
,, ,, ..	Cranes	—	614,000	
,, ,, ..	Manual labor ..	—	586,888	586,888
	Total tonnage			8,521,000

Note.—By "native vessels" it is meant the native sailing schooners, lighters, and tow barges of all kinds such as are used in these ports and on the Inland Sea. Of the tonnage which is transferred to the lighters some small part is either re-shipped by schooners or transferred to steamships within the Port, or to the local storage.

Below is given a Table showing these figures classified according to the method of loading.

Table VIII

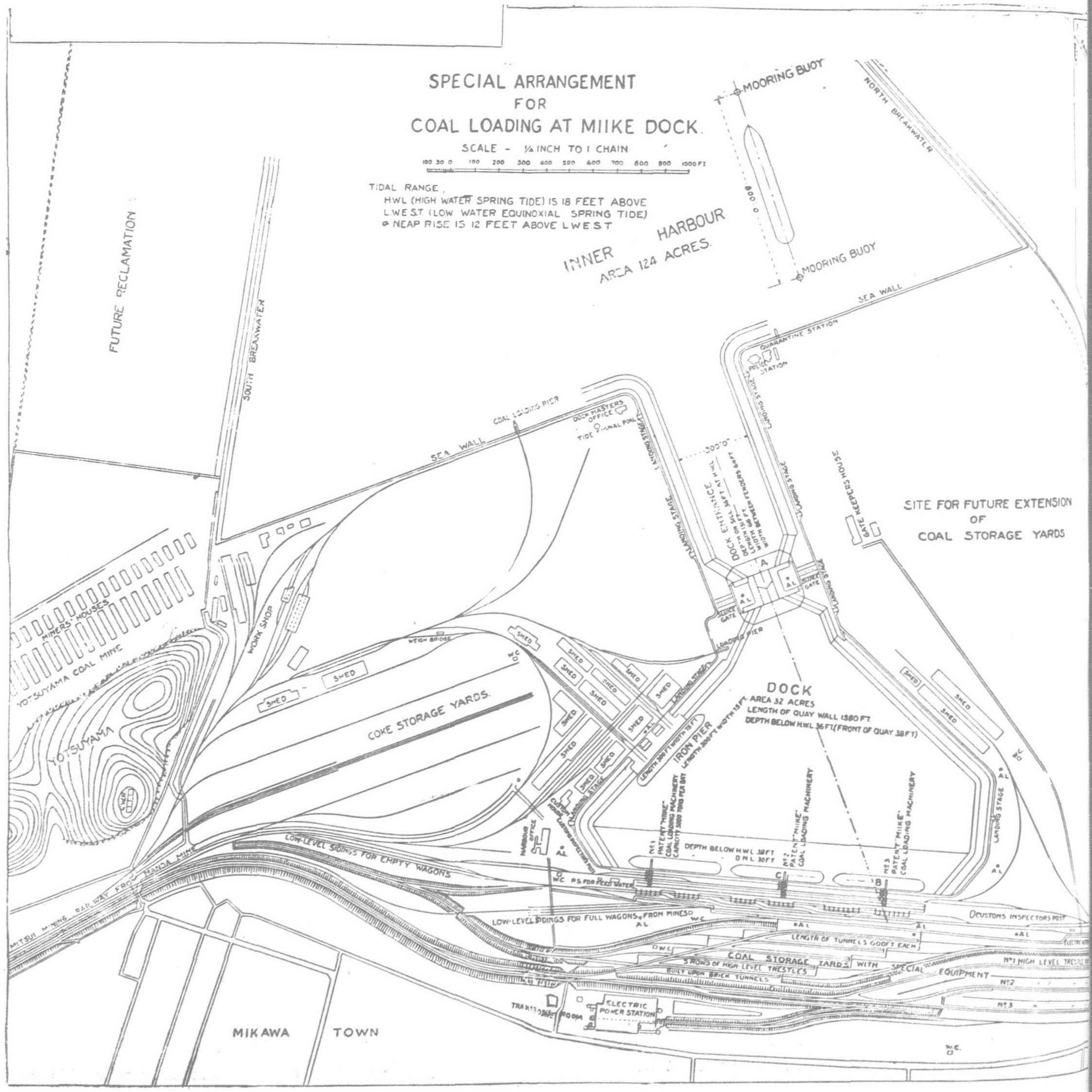
	Mechanical loading (tons)	Loading from storage	Mid-stream loading	Manual loading	Total
Steamship cargo ..	1,704,000	231,000	1,193,000	—	3,128,000
Steamship bunker..	—	—	—	342,000	342,000
		coal pier loading			
Native vessels cargo	1,626,000	2,911,000	—	514,000	5,057,000
Total tonnage					8,521,000

(6) Loading Costs :—Wakamatsu Harbor Co. owns the port equipment and charges the following port dues :

For all steamships, 10 sen per ton of coal shipped.

For all native vessels, 2 sen per ton of coal shipped.

As for the use of the mechanical equipment, the Imperial Government Railways permit shippers a free use of all equipment except the Brownhoists at Tobata side, where a charge of two sen per ton is levied for the loading steamships only.


SPECIAL ARRANGEMENT
FOR
COAL LOADING AT MIIKE DOCK.
SCALE - ¼ INCH TO 1 CHAIN
100 50 0 100 200 300 400 500 600 700 800 900 1000 FT
TIDAL RANGE,
HWL (HIGH WATER SPRING TIDE) IS 18 FEET ABOVE
L.W.E.S.T (LOW WATER EQUINOXIAL SPRING TIDE)
& NEAP RISE IS 12 FEET ABOVE L.W.E.S.T
INNER HARBOUR
AREA 124 ACRES.
MOORING BUOY
MOORING BUOY
800' 0"
NORTH BREAKWATER
SEA WALL
QUARANTINE STATION
FUTURE RECLAMATION
SOUTH BREAKWATER
SEA WALL
COAL LOADING PIER
DOCK MASTERS OFFICE
SITE FOR FUTURE EXTENSION OF COAL STORAGE YARDS
MINERS HOUSES
YOTSUYAMA COAL MINE
YOTSUYAMA
WORK SHOP
SHED
COKE STORAGE YARDS
DOCK
AREA 32 ACRES
LENGTH OF QUAY WALL 1380 FT
DEPTH BELOW HWL 36 FT (FRONT OF QUAY 38 FT)
IRON PIER
LOW-LEVEL SIDINGS FOR EMPTY WAGONS
LOW-LEVEL SIDINGS FOR FULL WAGONS FROM MINES
COAL STORAGE YARD WITH SPECIAL EQUIPMENT
ELECTRIC POWER STATION
CUSTOMS INSPECTORS POST
MIKAWA TOWN

A

The average costs of actual loading with the use of different classes of equipment for different vessels are as follows :—

Table IX.—Actual Loading Costs (Mechanical)

Method	Kind of vessels	Cost sen per ton
Brownhoists	Steamship	33
,, ...	Native vessels	17
Hoists	,, ,,	15
Cranes	,, ,,	15
Coal pier	,, ,,	15
Direct from storage	Steamships	100
Storage to ships at anchor ..	,,	150 to 170
Direct from storage	Native vessels	60
Storage to ships at anchor ..	,, ,,	140 to 150

(B) Miike Harbor

(1) Area :

Inner harbor	150,000 tsubo
Dock space	40,000 ,,

(2) Harbor Equipment :

Break water and ships channel :

Length	6,000 feet
Width	450 ,,
Depth (at low tide)	24 ,,

Loading quay :

Length	1,380 ,,

It is possible to dock and load three 10,000 ton class steamships at one time.

Lock :

Width	66 feet

The lock gate consists of two re-inforced steel members, operated by the hydraulic pressure.

Depth	28 feet

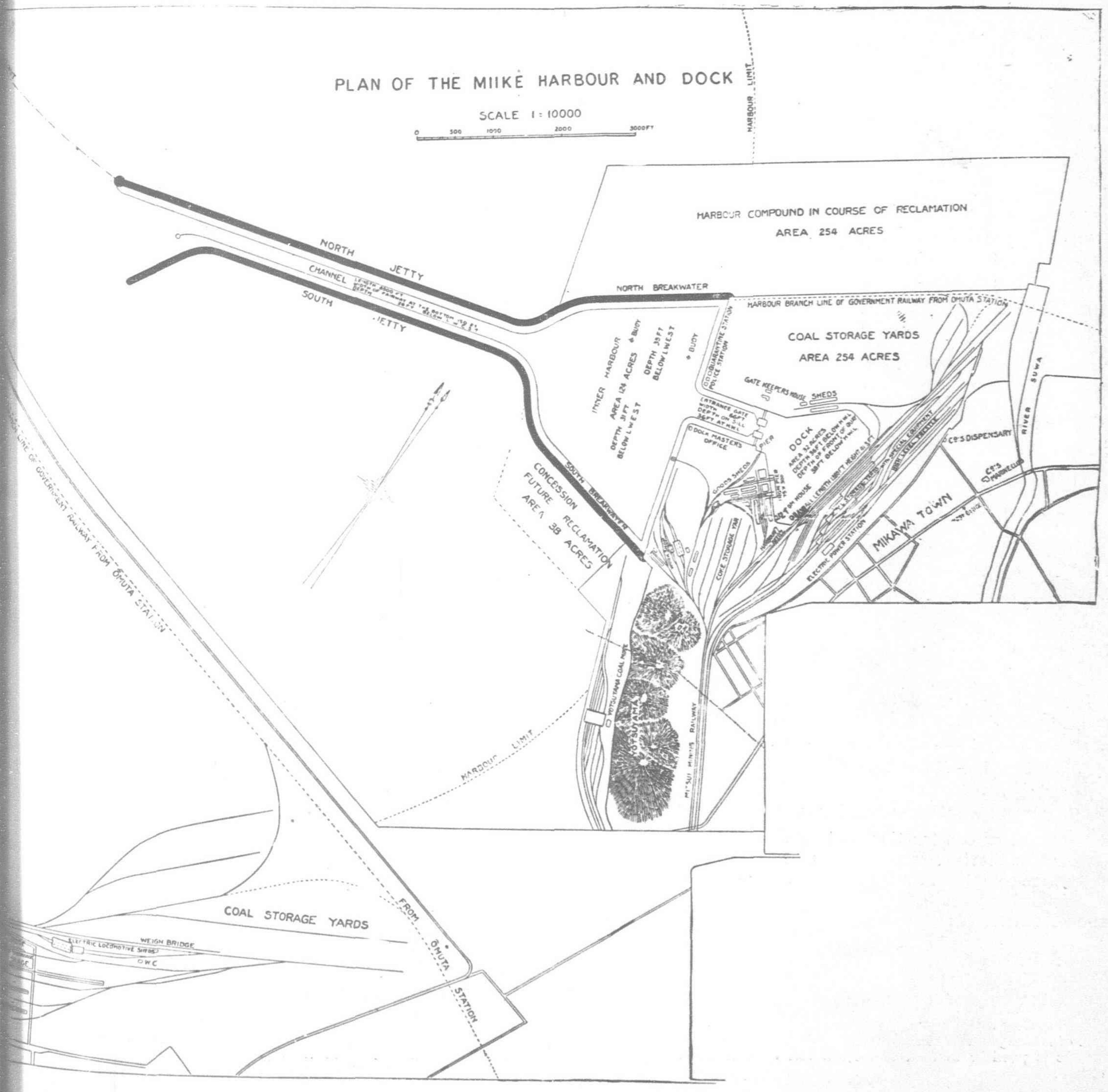
Inner harbor :

Depth	31 to 35 feet

(3) Loading Equipment :—(*a*) There are five elevated tracks onto which the loaded wagons are brought. From the wagons coal is emptied into smaller transfer wagons which are drawn up to the loaders by electric locomotives.

(*b*) When it is desired to load the ships from storage, the coal is loaded onto transfer wagons by means of either belt-conveyors or manual labor, which in turn are brought to the loaders by electric or steam locomotives.

(*c*) There are three loaders of Miike's special design operating along the eastern quay of the dock.



B

(*d*) For loading ships which can not be brought within the dock there is another loader operating along the eastern quay of the inner harbor.

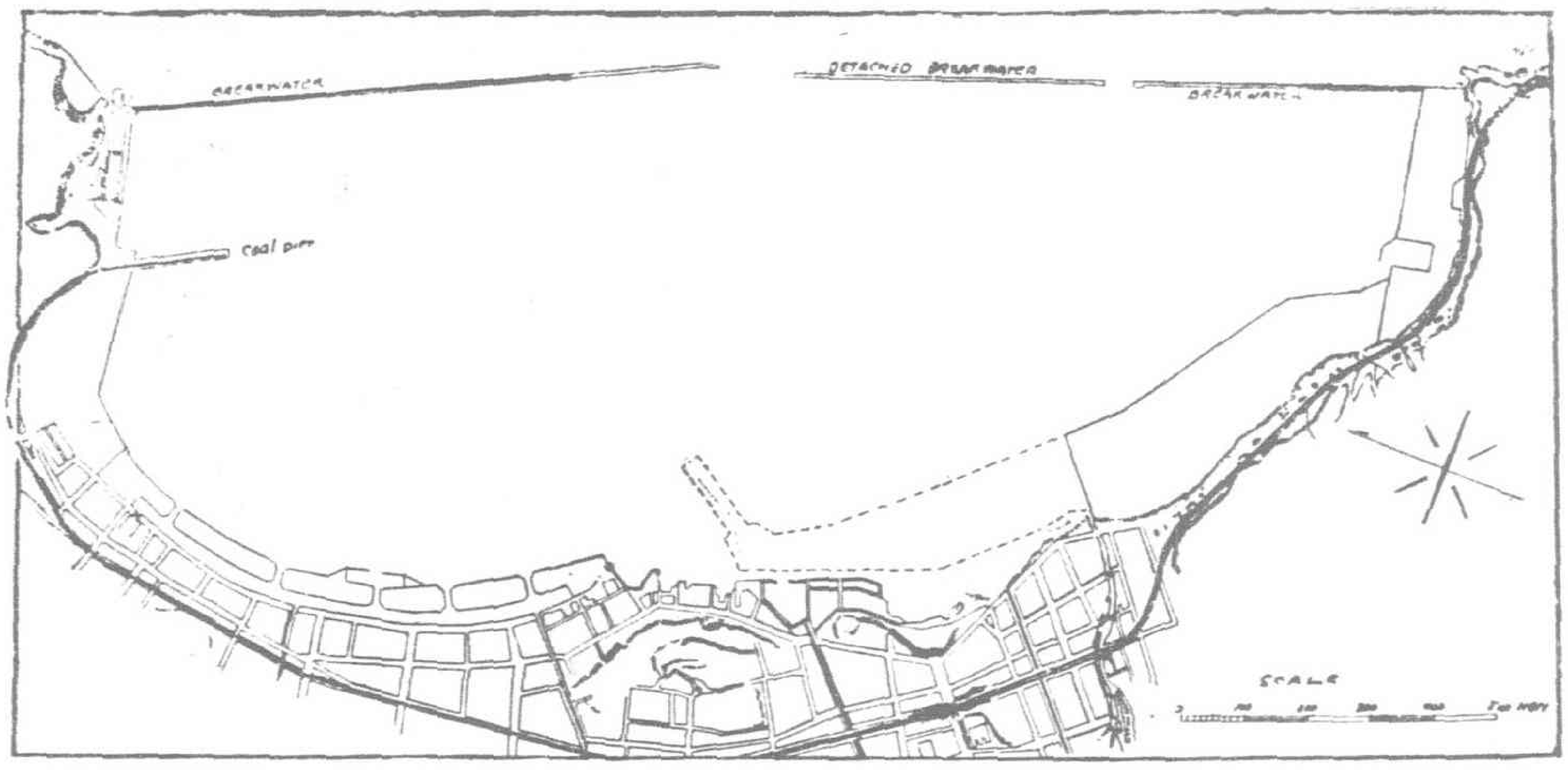


Fig. 11.—Otaru Harbor

(4) Loading Capacity :

Dock per loader per day	5,000 tons
Inner harbor loader per day	4,000 ,,

During 1927 a total of 1,650,000 tons was loaded and shipped from Miike Harbor, details as follow :

Cargo coal for domestic use	130,000 tons
Cargo coal for export	760,000 ,,
Bunker for domestic ships	520,000 ,,
Bunker for foreign ships	240,000 ,,
Total	1,650,000 ,,

(5) Loading Costs :—Since at this port all equipment is owned and operated by the Mitsui Mining Company, figures on loading costs are not available, but it is inferred that the Port operates very economically.

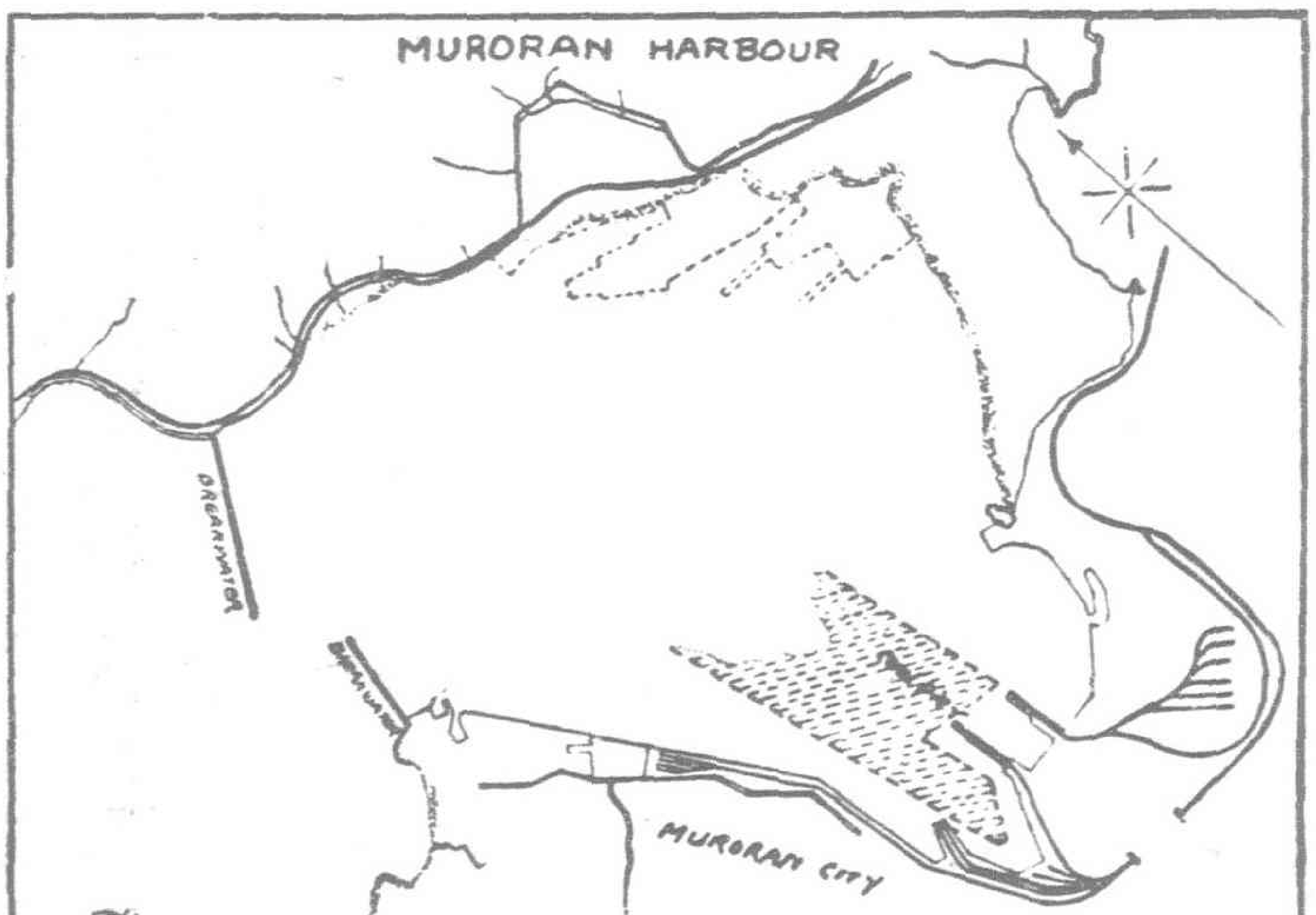


Fig. 12.—Muroran Harbor

(C) Otaru and Muroran Harbors

In 1908 the work of construction of two similarly designed coal loading piers was started, one at Otaru and the other at Muroran. They were completed three years later and their general use started the following year.

(1) Harbor Equipment :

Coal loading piers :

Height (at high tide)	61 feet
Width (at top)	57 ,,
Width (at base)	70 ,,
Length	951 ,,
Depth (at low tide)	24 to 26 feet
No. of loading chutes at either side ..	20

It is possible to load two 4,000 ton type steamships at either side.

(2) Loading Methods :—For cargo shipments loaded railway wagons are drawn or pushed onto the pier, where the coal is dumped into chutes and dropped into the steamship's hold. When it is desired to load from storage the wagons are first loaded by manual labor and then taken onto the pier as before. At Muroran there is a special type of pontoon loader, owned and operated by Hokkaido Tanko Kisen Kaisha, which is in principle a conveyor loader.

For bunker coal loading this loader is sometimes used but in the majority of cases the manual method of loading is resorted to. Sometimes the coal is loaded with a rope sling basket of approximately one ton capacity. At other times the coal is first scooped into straw bags within the lighter, and then these bags hoisted by the ship's winches, at a rate of about ten bags per hoist.

(3) Loading Capacity :—It is possible to load approximately 2,000 tons per day per ship from a coal loading pier, about the same amount of bunker loading with ships at anchor and about 3,000 tons per day per ship by Hokkaido Tanko Kisen Kaisha's loader at Muroran.

A table is shown below giving the result of 1927 loadings both at Muroran and Otaru.

Table X

Port	Cargo (tons)	Bunker (tons)	Total	Pier	Lighter Loading
Otaru ..	740,000	770,000	1,510,000	670,000	840,000
Muroran ..	1,830,000	340,000	2,170,000	1,810,000	360,000

(4) Loading Costs :—The cost of loading at Otaru and Muroran varies under different conditions but the following is taken as an average.

Table XI

Method	Cost per ton
From coal pier direct	30 to 35 sen
From storage and coal pier	70 to 80 sen
By lighter to steamship	100 to 150 sen

(D) Moji Harbor

Until about 1907 Moji was a busy coaling port, shipping sometimes over 3,000,000 tons annually ; but as the neighboring port of Wakamatsu, which is more conveniently situated for coal transportation and loading, began to thrive very actively in the trade, Moji's tonnage of coal shipments began to decline, so that at the present time it does not attain one half the amount of the former flourishing period. It is noteworthy also that practically all of Moji's coal shipment is for bunker use.

The coal is either transported by rail and stored, or brought to Moji from Wakamatsu on lighters. Sometimes these lighters discharge to the steamships directly, and at other times the coal is brought ashore and put in storage.

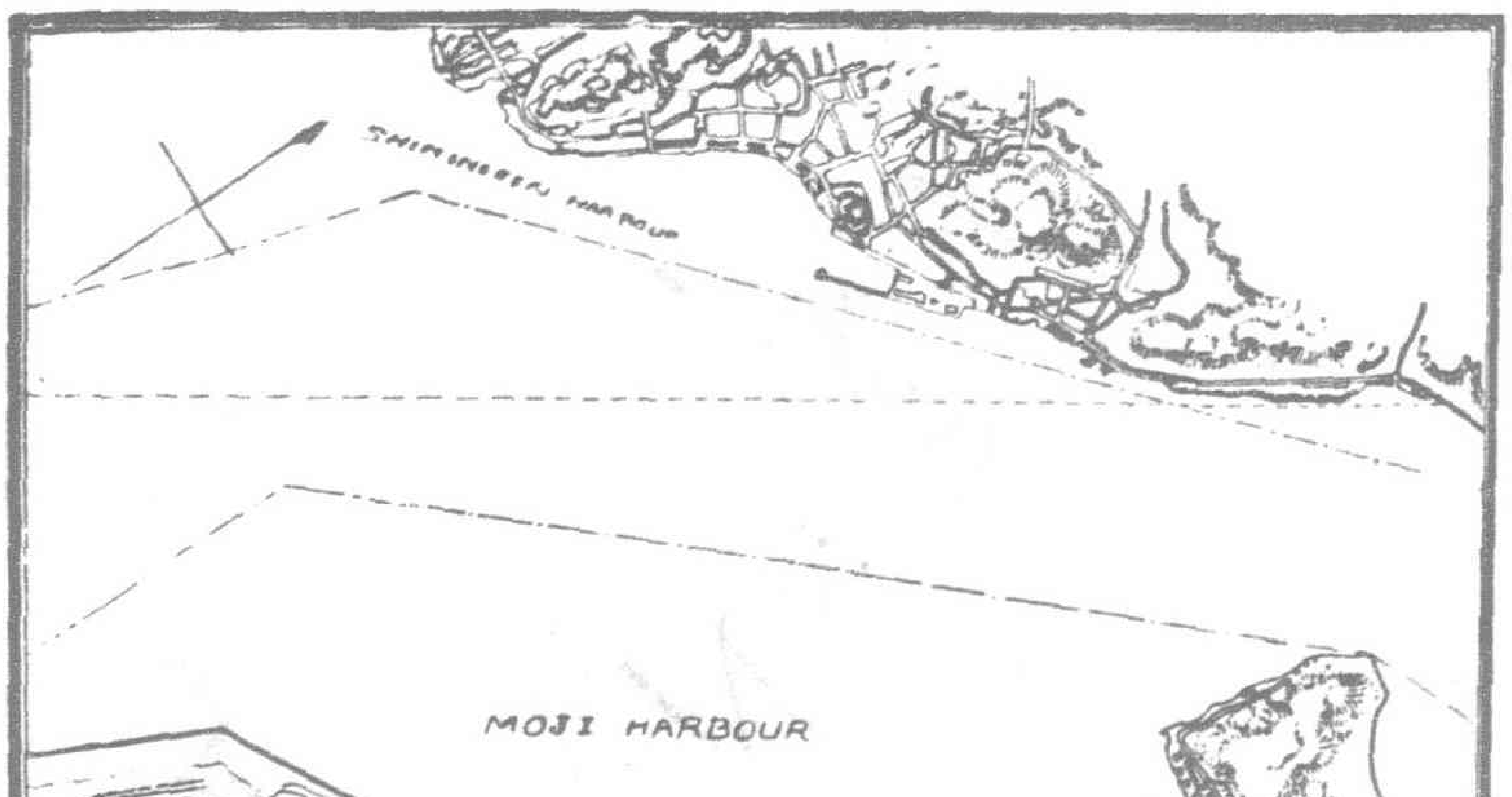
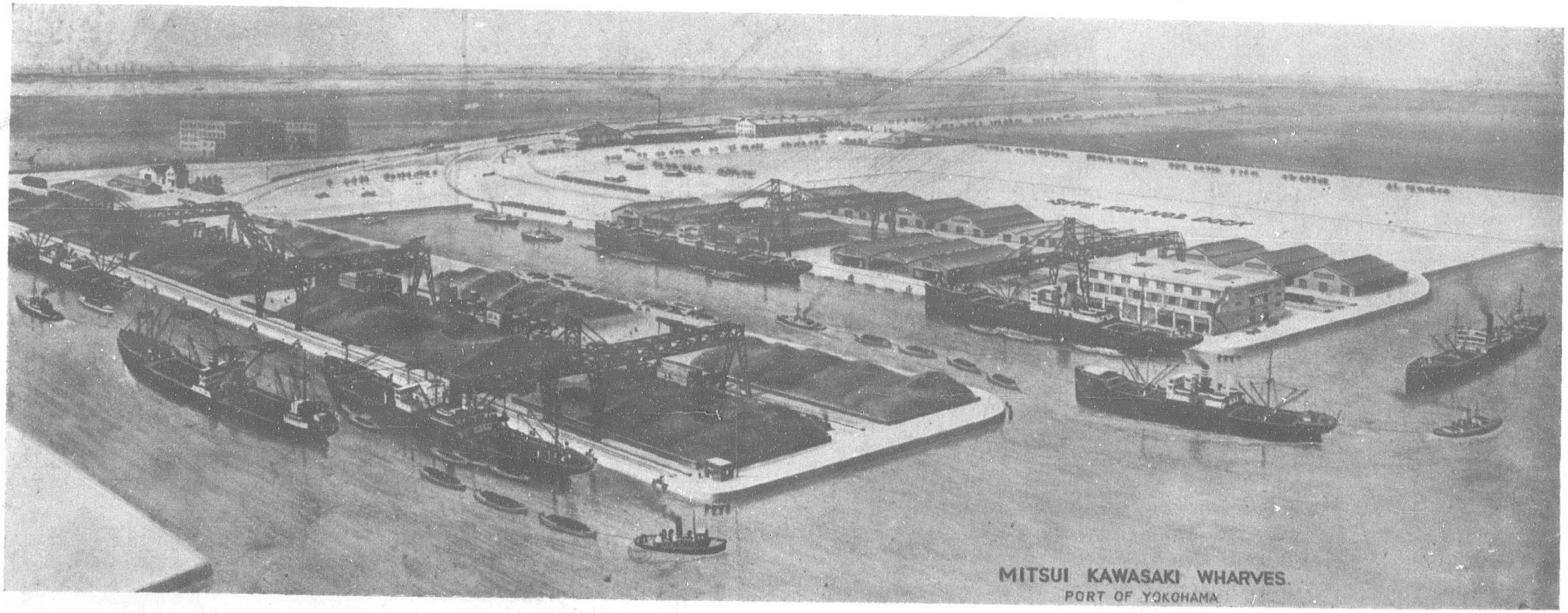
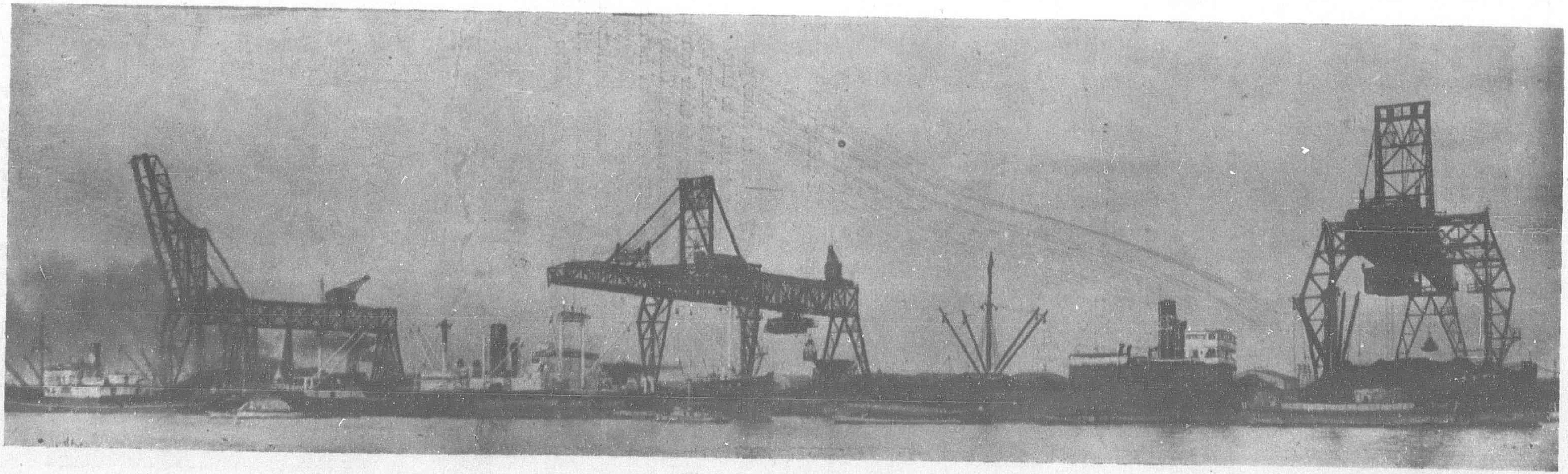


Fig. 13.—Moji Harbor

MITSUI KAWASAKI WHARVES, PORT OF YOKOHAMA

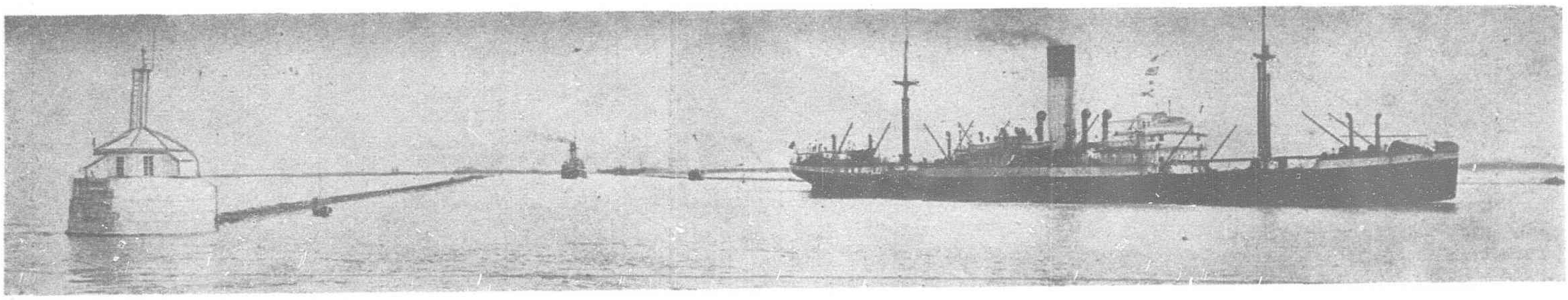
Coal Handling and Storage Plants Equipped with Five Demag Bridge Transporters



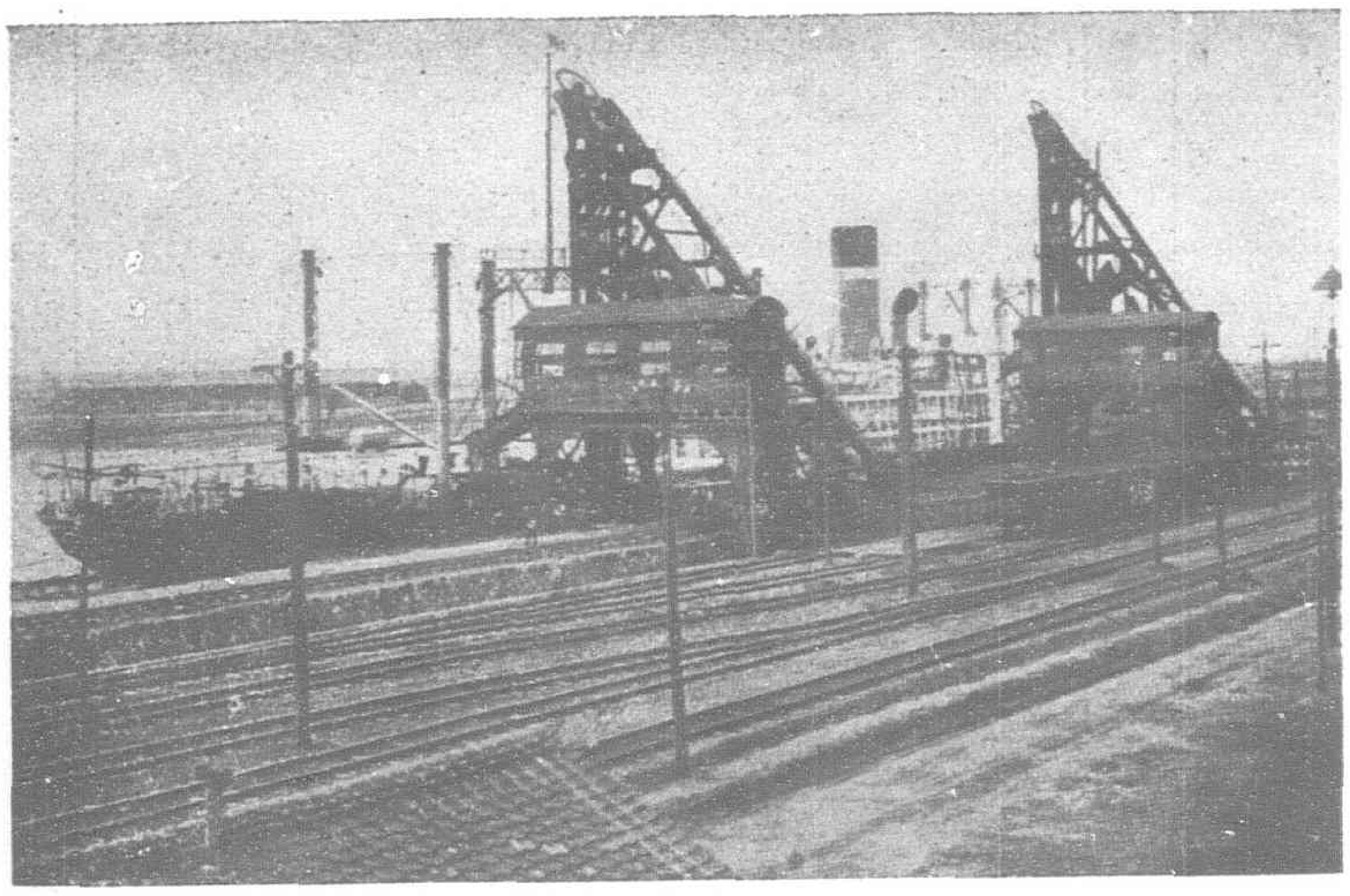


View from Canal

MIIKE COAL HARBOR AND MITSUI DOCK

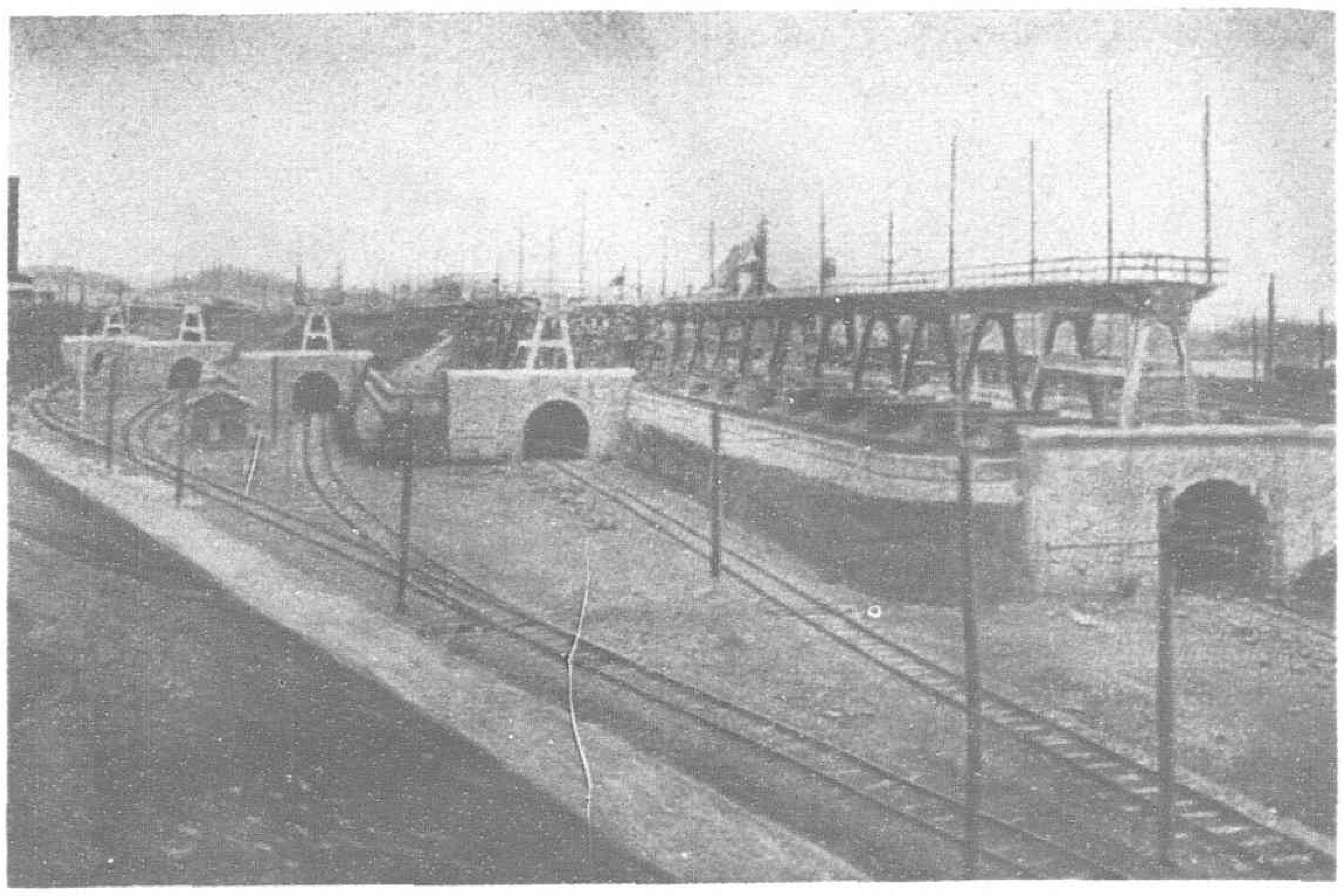


Entrance to the Inner Harbor



Patent Miike Coal Loading Machinery

2



3

Five Rows of High-Level Trestles Built upon Brick Tunnels

There are no facilities at this port to effect pier loading directly to steamships. It is, therefore, necessary to employ manual labor for both unloading railway wagons and loading lighters ; with the exception that Nippon Yusen Kaisha use their own loaders for the purpose, to serve their own fleet of ships. There are two sets of these loaders, constructed in 1926, capable of handling coal at a rate of 200 to 240 tons per hour.

(1) Loading Method :—The loaded lighters are brought alongside the ship, and the process of manual loading as described under Wakamatsu Harbor is usually used. More often, however, bunker coal is taken on in bamboo baskets by the ship's winches and the coal loaded directly into the hold. The reason for the prevalence of the latter method is that comparatively larger ships call at Moji, so that the step and basket method becomes too cumbersome as the ship's sides are too high above water.

(2) Loading Capacity : With larger ships it is possible to conduct loading operations at four places, two at each side. With the step and basket method it is possible to load from 20 to 25 tons per hour per unit. With the other method 35 to 40 tons can be loaded per hour per unit.

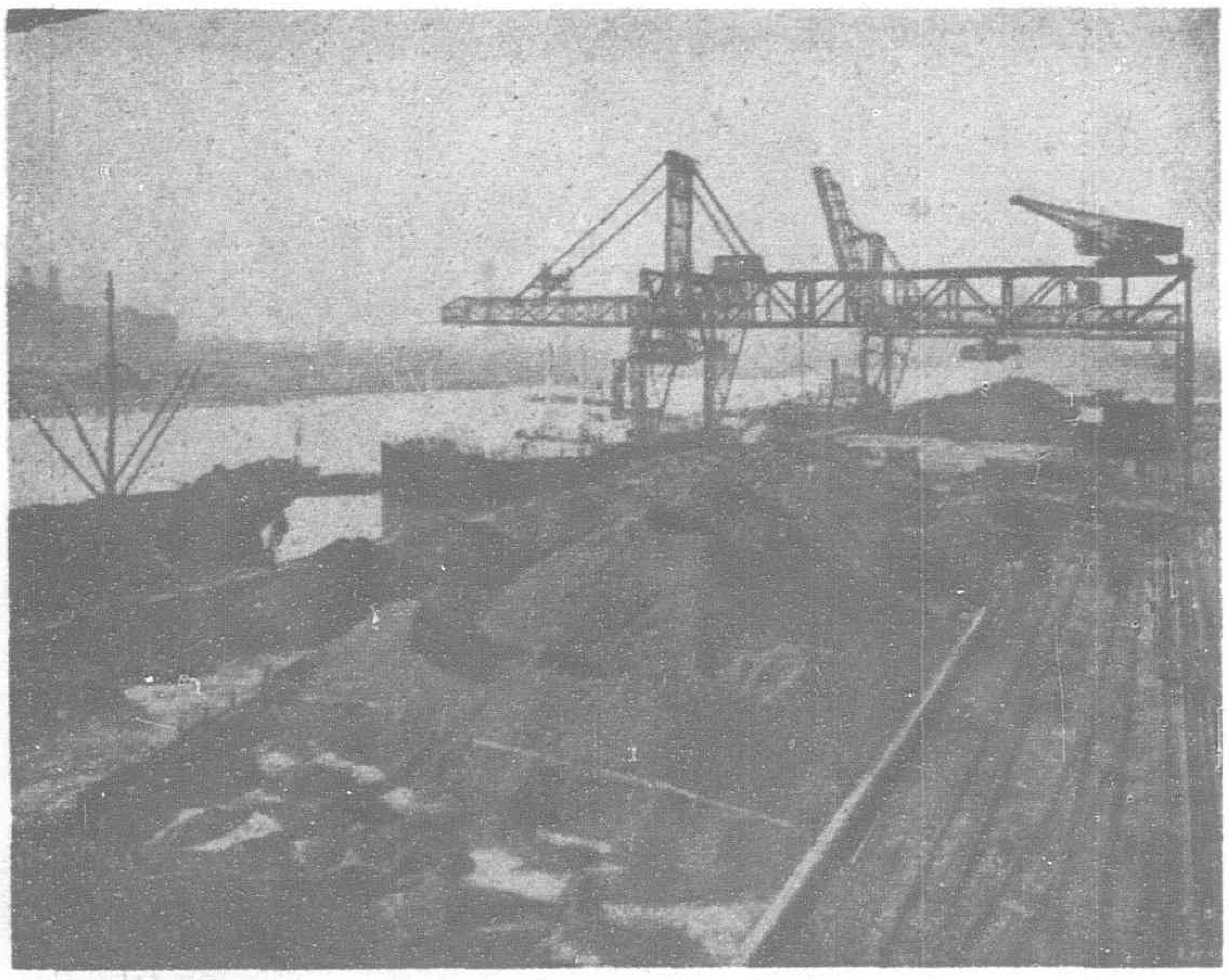


Fig. 16.—View Showing Unloading Operations at Kawasaki

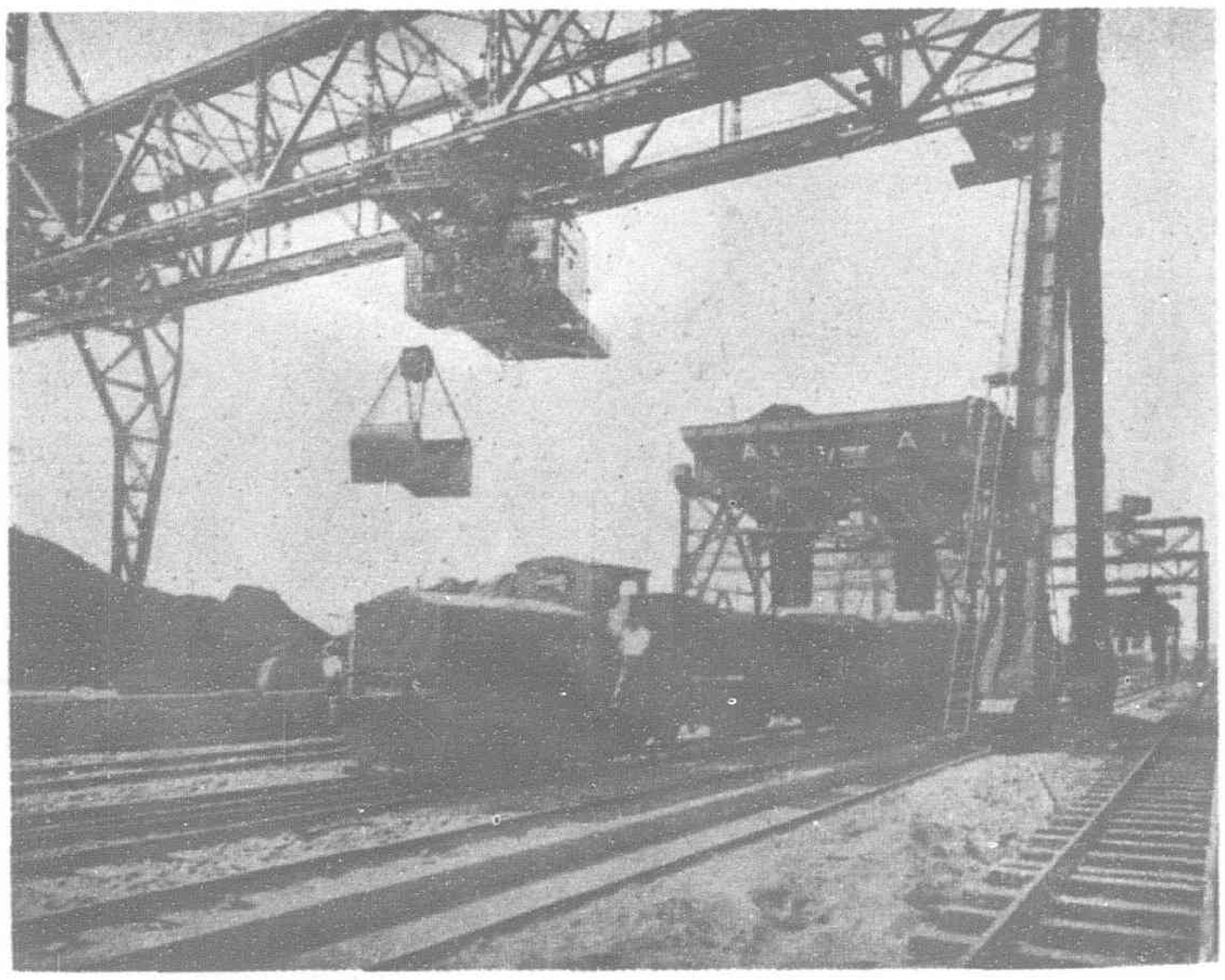


Fig. 17.—View Showing Bridge Transporters and Hoppers at Kawasaki

(3) Loading Costs :—The average loading costs at this port are as follows :

Table XII.—Loading Cost at Moji

Kind of vessels	Method	Cost sen per ton
Native vessels	From storage at quay	90
Steamship	From pier to midstream	220 to 230
,,	From Wakamatsu by lighters	190 to 200

Landing Method

(*a*) General Practice :—It will be noted, as has been described in the preceding pages, that with the exception of Miike Harbor, at all the other loading points the Imperial Government Railways have provided loading facilities sufficient to cope with the present amount of traffic to which every coal handling firm has access. At Miike Harbor there is a little more elaborate loadling equipment. Obviously it has not been possible, however, to install machinery and mechanical equipment on a large scale for landing of coal shipments, due to the diversified interests of the coal merchants concerned.

In Tokyo and Osaka there are only two or three coal merchants who handle tonnage in excess of 300,000 tons per annum. Even these few merchants have little necessity for large scale mechanical equipment ; because in and around Osaka the coal that has been shipped from Kyushu in native schooners and barges is usually delivered directly to the consumers without transshipping, and in the case of Tokyo and vicinity the coal has to be taken on lighters and delivered in bulk to the consumers, or to storage compounds.

Looking at the question from the consumer's standpoint one readily sees that as the largest consuming class, *viz.* steamships take their coal mainly at the shipping port, and as the second largest consumer, the Imperial Government Railways, takes delivery of a greater portion of this demand at the mines, there is little necessity of many large-scale facilities either in Tokyo or Osaka. There is, of course, the Imperial Steel Works, which consumes much in excess of 2,000,000 tons annually ; but even this consumer obtains practically his entire demand by rail directly from the mines, although some twenty per cent. of the total consumption is imported from foreign countries for the purpose of mixing with the domestic coal to obtain a proper grade of coke for steel making. This imported coal is naturally landed directly from steamships by the Steel Works' own equipment. There are many other factories of importance throughout the country, but few whose demand exceeds 100,000, tons annually in one place. Thus, there are no other large consumers who have facilities for unloading from steamships directly into their own compound.

The coal traffic condition in Japan being thus, it is but natural that effort should be directed toward unloading equipment for native vessels only. There have been constructed in recent years a number of such facilities but none of them is worth mentioning, their capacity being only 40 to 50 tons per hour.

There is, however, an equipment quite worthy of mention, which was constructed in 1928 at Kawasaki, midway between Tokyo and Yokohama, by Mitsui Bussan Kaisha. This docking and unloading equipment, while it is used for other purposes, is the first of its kind in Japan, which makes it possible to unload from large ocean-going steamships directly onto railway wagons or dock storage. An attempt is made to give here a brief description.

(*b*) Mitsui Kawasaki Wharves :—Mitsui Bussan Kaisha's Kawasaki Wharves are located at Kawasaki on the main ship channel from Yokohama Harbor to Tokyo. Their general layout is as shown in the following sketch (Fig. 14), and the general physical features are as follows :—

Total Area	58,900 tsubo
Depth of water at low tide	30 to 35 feet
Railway tracks	3½ miles

Wharves.—A dock has been dredged, measuring 300 feet wide and 1,090 feet long, making a total docking shore line of 5,330 feet. Provision is made to construct another dock of similar size for future extension. With the present equipment it is possible to dock and unload eight steam ships of 5,000 to 6,000 tons at the same time.

Unloaders.—There are at present three unloaders of the bridge-transporter type, all movable for the entire length of the wharf. (Fig. 15, 16 and 17). On the under side of the main truss of each transporter is a travelling crab which can revolve on a 20 feet radius. On the top is a travelling slewing crane which can revolve on a 40 feet radius. The capacity of the former is five tons, that of the latter being two tons. Their general dimensions follow.

Length of transporters between legs	182 feet
Length of luff jib	118 ,,
Height, between truss and rail	57 ,,
Capacity of unloading crab (per hour)	250 tons
Capacity of slewing crane (per hour)	90 ,,

Wagon and truck loading.—The coal which is to be conveyed by water is usually taken onto lighters either directly from the ship or from storage ; that which is to be re-shipped by railway wagons or motor trucks is loaded from hoppers. There are 36 such hoppers within the compound, 23 60-ton stationary and 8 70-ton movable hoppers being used for railway wagon loading, and 5 30-ton movable hoppers for motor trucks. Previously, when loading was done manually it took from 8 to 10 laborers to load a 15-ton wagon in 30 to 40 minutes ; but with these hoppers it is possible to load a wagon of the same size within two minutes with scarcely any manual labor. So economical is the loading equipment that it requires only 10 laborers to do the entire loading within the compound.

Operating results.—Since the Kawasaki equipment was completed and put in operation only in November, 1928, it is impossible to obtain extensive operating data. For a half year period since the opening the amount of coal handled has been as follows :—

Table XIX

Total tonnage unloaded	611,090 tons
Landed and Transferred to lighters (by mechanical unloaders)	330,570 ,,
Landed and Transferred to lighters (partially by manual labor)	280,520 ,,
Wagon loadings (by hoppers)	139,800 ,,
Truck loadings (by hoppers)	36,260 ,,

It is the custom at Yokohama, where no mechanical unloaders are employed, first to discharge the coal cargo into lighters by means of two ton rope wickers and the ship's winches, and then to conduct these lighters to consumers wherever that is possible. Where such delivery method is not feasible the coal is landed from the lighters for purpose of reshipment by railway or to small and local consumers. It is therefore apparent that much saving can be effected by the use of the Kawasaki unloading equipment.

As an illustration of the above statement, comparative unloading data is given for similar types of vessels and under similar conditions : one for Yokohama Harbor, where manual labor was employed, the other the result of mechanical unloading at Kawasaki.

Table XX.—Yokohama Harbor (Manual Method)

Name of steamship	*Mandai Maru*
Cargo (coal)	6,000 tons
Amount of labor required	225 man days.
Duration of anchorage	36 hours
Net discharging time	20 hours

Kawasaki Wharf (Mechanical Method)

Name of steamship	*Kinkazan Maru*
Cargo	7,670 tons.
Amount discharged mechanically	6,850 ,,
Amount discharged manually	820 ,,
Amount of labor required	80 man days
Durltion of anchorage	28 hours
Net discharging time	20 hours

It is apparent from the foregoing that where a ship's coal cargo is being discharged to lighters and sent directly to consumers the advantage of the mechanical method over the manual is not very great ; but where the coal requires to be stored and sent subsequently to consumers by means of railway wagons or motor trucks the advantage is very marked. The saving comes not only from the elimination of unnecessary handling connected with lighter transshipment but from lessening the time of detention of steamships.

It is superfluous to state that such equipment is justifiable only where a large amount of coal is handled in one place as in this case. Mitsui Bussan Kaisha is contemplating to build a similar coal handling equipment at Osaka. Other firms no doubt will follow the example when it is seen how necessary it is to handle coal in larger bulks than is the general custom to-day.

Comparative Economic Aspects of Oil-burning Steamships and Internal Combustion Motor Ships

Teijiro Kawamura, Managing Director, Mitsui Bussan Kaisha, Limited

The growing popularity of motor ships as a superior type of modern vessel shows to a marked degree in the shipping world of to-day.

Seven years ago, however, the annual tonnage of the world's motor ships amounted only to something like 10 per cent. of that of the steamships. Rapid strides have since been made in this connection. In fact, in the middle of 1927 the motor ships were already outstripping the steamers by some 6 per cent., and at the end of 1928 by about 35 per cent.

What is the cause of such enthusiasm in the construction of motor ships? It must certainly be the result of the universal recognition of their superiority over steamers in economic efficiency.

Reports from various sources already give information on the comparative economic efficiency of coal-burning steamers and motor ships using oil. These reports confirm the fact that motor ships require far less bunker space, giving a greater cargo capacity, which means a remarkable increase in freight-earning power. The difference in this connection is so wide that coal-burning steamers cannot hope to approach the economic efficiency of motor ships, even if coal is exceptionally cheap.

But how would oil-burning steamers compare with motor ships on this point? We appear to have very little information so far.

In order to compare the economic value of motive power generated by steam in oil-burning boilers, and that generated by internal combustion, the Mitsui Bussan Kaisha, Limited, made an extensive experiment.

In 1924, they built a cargo motor ship the *Akagisan Maru*—the first of its kind in Japan—of 7,000 tons D.W. type, carrying a Burmeister & Wain type Diesel engine.

At the same time, they had an oil-burning steamer, the *Akibasan Maru* specially built in a corresponding type.

The company ran these ships on the same line—between Japan and the Pacific Coast of North America—for four years, observing the results of the respective ships. It has been proved conclusively that in actual operation the motor ships is still superior to the oil-burning steamer. I wish to present some observations on the results, for reference.

These may be of small value from the technical or scientific point of view, still I venture to submit them as a reference in the hope that they may prove of some slight service.

Comparisons of the economic efficiency between coal-burning steamships and internal combustion motor ships have appeared from time to time, but seldom do we find reports showing comparative economic results of the oil-burning steamship and the internal combustion motor ship.

In the hope of supplying some material for reference in this connection, we shall now try to examine the economic results obtained from the actual operation of the two ships owned by the Mitsui Bussan Kaisha, Limited :—

Internal combustion motor ship *Akagisan Maru* and Oil-burning steamship *Akibasan Maru*.

First, we shall give particulars of the hull and engine of the respective ships.

	Akagisan Maru	*Akibasan Maru*
Dimensions :		
Length B.P.	375 ft.	375 ft.
Breadth molded	50 ,,	50 ,,
Depth molded	30 ,,	30 ,,
Deadweight	6,981 tons	7,151 tons
Gross tonnage	4,635 ,,	4,670 ,,
Engine	B. & W. 6-cylinder single shaft, long stroke, slow running type.	Triple expansion engine, single shaft. Steam pressure 200 lbs.
Bunker hold	None	9,225 cub. ft.
Hold space	341,242 cub. ft.	432,133 ,,
Deep tank oil space	19,170 ,,	21,407 ,,
Total Hold Space	360,412 ,,	363,540 ,,
Double-bottom oil tank	716 tons	738 tons
Engine room space	607 ,,	661 ,,
Wieght of engine including auxiliary engine	517 ,,	445 ,,
I.H.P. generated at trial trip ..	2,350 tons	2,850 tons
Speed Trial	12 knots	15 knots
Draft at trial trip		
Fore	9′ 1″	8′ 3″
Aft	14′ 7″	15′ 1″
Mean	11′ 10″	11′ 8″
Building completed and when sailed for maiden trip	July 23, 1924	Nov. 18, 1924

These two ships were used exclusively on the Pacific line between Japan and North America. It is, therefore, understood that all the following points are from actual results obtained on this line.

I—Difference In Engine Room Space

In the above description it will be seen that the engine room space in the *Akagisan Maru* is 607 tons, whereas the *Akibasan Maru* is 661 tons, that is, the motor ship has 54 tons or 5,400 cubic feet less.

As the space given above includes engine casing, we have to note the following items on space which otherwise might be available for cargo.

	Akagisan Maru Engine room Tons	*Akibasan Maru* Engine room Tons
Below 'Tween deck	355.60	384.31
'Tween deck	72.90	116.33
Shaft tunnel	59.19	56.87
Total	487.69	557.51

It will thus be seen that the *Akagisan Maru* takes 69.82 tons or 6,982 cubic feet less space.

In spite of this fact, the *Akibasan Maru* actually has 3,128 cubic feet more in the hold space. This is caused by the longer bridge deck provided in the steamer. If the dimensions of the bridge deck were equal in both ships, the motor ship will naturally have more hold space, from that economized in the engine room.

In this way, the *Akibasan Maru* has more hold space left, compared with the motor ship, but she has some drawbacks owing to the following facts :

The steamer has a permanent bunker space 9,225 cubic feet, which is not available for cargo.

As she loads, in North America, fuel oil required for the voyages back and forth, the deep tank on the return voyage, is filled up with her own fuel oil, making it impossible to use the tank for cargo on that voyage.

II—More Cargo Space in the Motor Ship

Taking into consideration all the above we have the following result of comparative cargo space :

	Akagisan Maru Cub. ft.	*Akibasan Maru* Cub. ft.
Voyage Outward	360,412	363,540
Voyage Inward	360,412	332,908
Total	720,824	696,448

which shows that the *Akagisan Maru* has 24,376 cubic feet more cargo space. Should she have the same bridge deck as the steamer, she would have altogether about 45,000 cubic feet more than the steamer.

Now let us examine the engine weight. The motor ship the *Akagisan Maru* has an engine 72 tons heavier than that of the steamer. This is owing to the engine being of the Burmeister & Wain's long stroke, slow running type, which is the heaviest type of the makers' engines. Besides this, the auxiliary Diesel engine is of special type, having 320 revolutions per minute, thus avoiding high speed. In addition to these, this being the first occasion to build a motor ship, special precaution was taken, and one extra starting air vessel was installed.

These are certainly disadvantageous to the motor ship. However, engines of more recent date are made very much lighter, so that if we take one of these lighter types as the basis of comparison, this disadvantage would naturally disappear.

We have noted that the engine weight is 72 tons heavier for the *Akagisan Maru*. However, taking into consideration the difference in the storage amount required for fuel and boiler water, the cargo capacity is greater in the case of this steamer.

The following is a comparison of the fuel and boiler storage :

EFFECT OF LESS FUEL CONSUMPTION

Voyage (Outgoing)	*Akagisan Maru*	*Akibasan Maru*
	Tons	Tons
Fuel oil for running	120	335
Fuel oil—reserve for 7 days ..	47	130
Drinking and Boiler water	50	100
Total	217	565
Voyage (Incoming)	*Akagisan Maru*	*Akibasan Maru*
	Tons	Tons
Fuel oil for running	335	930
Oil required while at anchor ..	6	50
Fuel oil—reserve for 7 days ..	47	130
Drinking and Boiler water ..	50	100
Total	438	1,210
Grand Total for Outgoing and Incoming Voyages	655	1,775
Difference	1,120 tons	

This will show that in one round trip the *Akagisan Maru* would load 1,120 tons (weight) less fuel oil and water. Deducting the difference of the dead weight, 170 tons, this would result in a net gain of 950 tons weight more cargo capacity for the *Akagisan Maru* for a round trip.

III—Reduced Engine Department Staff

A motor ship can generally do with a greatly reduced Engine Department staff, as compared with a steamer. In the present case, however, the *Akibasan Maru* is not coal-burning, but oil-burning, and thus the number of firemen has already been much curtailed. The motor ship, therefore, in this instance has only three men less than the steamer, as shown in the following table.

Engine Department	*Akagisan Maru*	*Akibasan Maru*
Officers	5	4
Men	7	11
Total	12	15

LESS EXPENDITURES FOR PAYROLL AND MESS

Payrolls for the entire crew inclusive of the Deck Department and stewards, cooks, etc. and the mess expenditures of the respective ships are shown in index numbers here. The Table shows that the payroll amounts to 13 per cent. less, and mess expenditures 4 per cent. less for the motor ship.

	Akagisan Maru	*Akibasan Maru*
Payroll, including bonuses	87	100
Mess Expenditures ..	96	100

IV—Diminished Expenditures for Repairs

Both ships have undergone four regular inspections since they were built, the expenditures of the Engine Department on these occasions are shown below :

	Akagisan Maru	*Akibasan Maru*
1925..	Y.3,551.00	Y.4,600.25
1926..	5,831.79	2,268.57
1927..	3,536.50	2,924.50
1928..	1,681.40	2,821.00
Total	Y.14,600.69	Y.12,614.32

In total amount, the expenditures for the *Akagisan Maru* exceed those for the other ship.

The reasons for this are: (1) lacking experience on Diesel engines, the whole engines were thoroughly overhauled at the regular inspection for the first three years, opening up almost all parts, thus entailing expenses for dismantling, erecting and carriage, (2) and then in 1926, a purifier for lubricating oil was installed, costing about Yen. 2,500 (3) the other reason being some alterations in piping, etc. which were made after the first result of the voyage was known. There was seldom any replacement of parts due to breakage or wearing out.

After the thorough-going inspection of all engine parts for the past four years, and being reassured of their safety and being fully convinced that it is not necessary at the annual regular inspection to open and inspect parts other than those prescribed in the Inspection Regulations, we opened some parts only at the 1928 inspection. As a result, the expenses incurred then for the Engine Department amounted only to some Yen. 1,600, or about half those required for the *Akibasan Maru*.

Just a word in regard to the repairing expense of Diesel Engines. It is the question of the life of a cylinder liner. The four years' service of the ship shows that the top part most worn out is confined to a small portion, and only to the extent of somewhat less than 1.8 millimeters. We expect the cylinder liner can be sufficiently servicable till the wearing out reaches six milimeters.

It would, therefore, not be required to replace it for seven or eight years yet to come. Assuming that it would become necessary to replace it after 12 years' usage it would probably cost Yen 1,200 each, or Yen 7,200 for all the cylinder liners. And assuming that a one-twelfth part of this amount be reserved each year, that would not make any excessive burden. We do not think there is any other part requiring considerable expenses for repair.

On the other hand, the *Akibasan Maru* required about the same amount of repair expenditures as the *Akagisan Maru*, up till now. But as her age advances, gradually increasing expenditures may be expected, as can be surmised from many actual examples. We expect, therefore, that as years pass, the difference in the repair cost of the two ships will grow and the *Akagisan Maru* will be requiring far less than the other.

V—Cost of Engine Department Supplies

In comparing the cost of supplies for the Engine Department, we have the following summary :

	Akagisan Maru	*Akibasan Maru*
1924 Latter Half	Y.16,658.63	
1925..	8,502.25	Y.10,288.06
1926..	7,327.75	3,567.50
1927..	6,997.72	3,330.04
1928..	6,973.98	3,074.10

It may be remarked that as the *Akagisan Maru* does not use steam at all, the kinds of supplies are different from those for an ordinary steamer, the great part of the supplies being lubricating oil.

Of the expenditures for supplies in the latter half of 1924, that is, at the time this motor ships was built, Yen 8,526.90 was the cost of the oil which was put into the lubricating oil storage tank.

The amount of consumption of lubricating oil greatly varies according to the type of the Diesel engine. We sometimes hear that oil valued at more than Yen 3,000 was consumed in a trip lasting some 40 days. Considering this, the present motor ship appears to be one of those which consumes the least lubricating oil.

The lubricating oil consumed during the four years since the ship commenced service amounts to approximately :

Cylinder Oil	5,730.5 gallons
Compressor Oil	1,984.5 „
Journal Oil	3,356 „
Total	11,071 gallons

Costing about Yen 21,000.00

which works out :

Average annual consumption : about 2,800 gallons

Costing about Yen 5,000

At the time the ship was built, great precaution was taken against the wearing out of various parts, hence an enormous quantity of lubricating oil was used. Besides this, no purifier being yet installed, some loss of oil was unavoidable, whenever the cleaning of the tank was necessary.

As we gained experience, such extraordinary precaution was found unnecessary, and as the purifier eliminated the loss, the consumption of the lubricating oil diminished, the following quantities being sufficient for a day's voyage.

Cylinder oil, about ...	6.5 gallons	
Compressor oil, about...	1.25 „	
Journal oil, about ...	3.25 „	(Taking into account some (slight leakage, etc.

Which would mean that henceforth the yearly consumption would cost about . ... Yen 3,500
Adding to it other general supplies ... ... ,, 1,500
Would give a total of ... ... ,, 5,000
Against this, the *Akibasan Maru* wouid require about ... ... 3,500 a year

The most expensive item of expenditure for the Diesel engine is said to be the supplies it requires. However, in the case of the *Akagisan Maru*, only Yen 1,500 is found necessary in excess of the corresponding item for the steamer.

VI—Smaller Consumption of Fuel by Motor Ships

As the chief items of expenditures have been dealt with, we now turn to the fuel consumption per day for each ship.

Year		*Akagisan Maru*	*Akibasan Maru*
1925 : 1st Half ..	During voyage ..	6.8 tons	21.1 tons
	While at acnhor..	0.361 ton	2.16 tons
	Average speed ..	10 knots	9.3 knots
2nd Half ..	During voyage ..	6.8 tons	19.6 tons
	While at anchor..	0.28 ton	2.45 tons
	Average speed ..	10 knots	1.05 knots
1926 : 1st Half ..	During voyage ..	6.6 tons	18.7 tons
	While at anchor..	0.28 ton	2.7 tons
	Average speed ..	9.4 knots	10 knots
2nd half ..	During voyage ..	6.68 tons	17.38 tons
	While at anchor—	0.26 ton	2.25 tons
	Average speed ..	9.75 knots	10.35 knots
1927 : 1st Half ..	During voyage ..	7.11 tons	17.49 tons
	While at anchor..	0.323 ton	2.14 tons
	Average speed ..	9.83 konts	10.17 knots
2nd Half ..	During voyage ..	6.82 tons	17.80 tons
	While at anchor..	0.225 ton	2.59 tons
	Average speed ..	10.52 knots	10.19 knots
1928 : 1st Half ..	During voyage ..	6.53 tons	18.63 tons
	While at anchor..	0.284 ton	2.90 tons
	Average speed ..	10.07 knots	9.95 knots
2nd Half ..	During voyage ..	6.65 tons	17.55 tons
	While at anchor..	0.253 ton	2.90 tons
	Average speed ..	10.03 knots	9.42 knots
Average of above ..	During voyage ..	6.74 tons	18.52 tons
	While at anchor..	0.283 ton	2.511 tons
	Average speed ..	9.95 knots	9.98 knots

The above figures will show that the *Akagisan Maru* consumes during voyage only about one-third the amount of fuel, while at anchor only about one-eighth the amount of fuel compared with the steamer.

Further, it may be remarked that in the case of the *Akagisan Maru*, the consumption includes not only that for main engine, but also for auxiliary engines and for room heating, which shows how economical the motor ship is in this connection.

Another point proved in this case is that while the steamer has the disadvantage of speed being diminished as years pass, the motor ship maintains the same speed as when she was built.

We shall now examine the receipts and expenditures of several voyages. In making the comparison, the ideal method would, of course, be to run a motor ship and a steamer, each of the same tonnage, at the same speed with similar cargo, on the same line, at the same season of the year, and at the same time. This, however, being extremely difficult for a shipping company not having a fleet of many similar ships, we can only supply information based on as similar conditions as possible.

The annexed Table shows the result of round trips, Japan—North America Pacific line. We have selected as far as possible results obtained at the same season, but being practically impossible to load, at all times, exactly the same kinds of cargo, the figures given, from strict sense, cannot be wholly satisfactory; but we shall have to be content with them under the circumstances. The following have been selected from the voyages made in the period extending from the beginning to the present time.

VII—Conclusion

To sum up, the Motor Ship *Akagisan Maru* has the following advantages over the Steamship *Akibasan Maru*.

1.—More Cargo Loading Capacity

As shown in the preceding Table, the motor ship is, with only a few exceptions, loading more cargo than the steamer.

2.—More Freight Income

Loading more cargo naturally leads to more freight income.

3.—Great Saving in Fuel Expenditures

As shown by the Index Numbers, the motor ship requires only about half the amount of fuel consumed by the steamer, proving conclusively the most salient feature of the motor ship.

4.—Port Charges and Miscellaneous Expenditures

No particular difference appears to exist fundamentally between the motor ship and the steamer. It all depends on the amount of cargo, or the number of ports of loading and discharging.

5.—Diminshing Ship's Charges

Compared with the steamer, the motor ship incurs more expense for writing off and interest charges, on account of higher building cost. The expenditures for supplies are somewhat higher also. Hence the ship's charges are more. On the other hand, less expenditures for payroll and engine repairs, and more freight income, as well as the saving in fuel, make the motor ship possible to net larger profits. Writing off, etc. may be sooner practicable, which would result in rapidly diminishing the ship's charges. This requires due attention.

6.—Certainty of Netting Profits

As shown in the preceding Table, the steamer sometimes shows net loss for the voyage, while with the motor ship such a case has never occurred. In voyage numbers 4, 9, and 11, the profit of the motor ship was less than that of the steamer, owing to having been detained longer for loading.

On the whole, we think we have been able to ascertain that the actual results support the theory advanced by modern science on the strong points of the motor ship.

Although the above conclusion has been based on the material which is not as complete as we might have wished, still these results obtained by the Mitsui Bussan Kaisha, Limited may be of some service to those who are interested in such subjects.

Akagisan Maru versus *Akibasan Maru*. Actual Accounts of Trading Japan/North America Round
(Each item of Akibasan Maru taken for 100)

Voyage No.	(1) Cargo Carried		(2) Gross Earnings		(3) Cost of Fuel		(4) Port Charges and Sundries		(5) All other Costs and Expense		(6) Profit	
	Akibasan Maru	*Akagisan Maru*	*Akibasan Maru*	*Akagisan Maru*	*Akibasan Maru*	*Akagisan Maru*	*Akibasan Maru*	*Akagisan Maru*	*Akibasan Maru*	*Akagisan Maru*	*Akibasan Maru*	*Akagisan Maru*
1	100	103	100	109	100	44	100	89	100	100	Loss	+
2	100	114	100	103	100	46	100	99	100	105	100	698
3	100	121	100	141	100	57	100	152	100	108	Loss	+
4	100	112	100	112	100	39	100	106	100	88	100	1,609
5	100	94	100	85	100	46	100	101	100	103	100	47
6	100	102	100	109	100	52	100	98	100	84	Loss	+
7	100	87	100	94	100	62	100	78	100	96	Loss	+
8	100	117	100	106	100	39	100	116	100	87	100	325
9	100	93	100	86	100	44	100	64	100	114	100	89
10	100	122	100	126	100	56	100	115	100	89	100	529
11	100	88	100	70	100	48	100	52	100	89	100	84
12	100	90	100	85	100	46	100	78	100	100	100	101
13	100	121	100	125	100	40	100	111	100	89	Loss	+
14	100	99	100	100	100	59	100	113	100	82	100	201

Note.—The Voyage Numbers on the table do not represent the actual voyage numbers of the vessels, but the mere numbers fixed for their voyages made in similar seasons. They are so numbered only for reference purposes. The voyages made at similar seasons are placed under the same voyage numbers so as to make comparison possible.

The Design and Performance of the Boilers of the "Viceroy of India"

By A. L. MELLOR

THE latest addition to the fleet of the Peninsular and Oriental Steam Navigation Co., the *Viceroy of India*, has been justly considered a great achievement for British shipbuilding.

This is the first high-pressure turbo-electric propelling machinery installed in a British liner, and Mr. R. T. Clarke, the superintendent engineer of the Company, is to be congratulated upon its success. Although the machinery has been fully described in the technical press, it was felt that some further particulars of the design and performance of the boilers fitted in this vessel would be of interest to the members of this Institution.

The specification called for a total output of 160,000 lbs. of steam per hour from six water-tube boilers at a pressure of 375 lbs. per square inch, and a steam temperature of 700 degrees F. from a feed temperature of 300 degrees F. The boilers, designed and built by Messrs. Yarrow & Co. to the order of Messrs. Alexander Stephen & Sons, the builders of the vessel, are arranged four in the after boiler room and two in the forward boiler room, together with two cylindrical boilers.

To suit the service conditions, the machinery was arranged by Mr. Clarke so that the four after boilers and either of the two turbo-generators could generate the power required for the reduced speed of the ship to Marseilles. For this reason, these four boilers are larger than the other two. Each of the four larger boilers has a generating heating surface of 5,700 square feet, a superheating surface of 1,820 square feet, and an air heating surface of 5,700 square feet. The corresponding figures for each of the two small boilers are 4,850, 1,550, and 5,000 square feet respectively.

Figs. 1 and 2 illustrate the general design of these boilers, which are of the five-drum single-flow type. There are three water drums connected to the saturated-steam drum by water tubes, and the superheater drum with its tubes is arranged between two of these generating elements. Fig. 3 gives a general idea of the outside of the boiler complete.

It will be noticed that with this design a large water surface is exposed to the furnace, and for this reason boilers of this type are remarkably steady and easy in steaming, and require very little renewal of the furnace refractories, as, owing to the high rate of heat absorption by radiant surface, the temperature of the gases in the combustion chamber is reduced to a degree which good quality firebricks can easily withstand. Of large volume, the combustion chamber has a shape which ensures the efficient burning of the fuel. The element on the side opposite to the superheater is a water screen with four rows of tubes, and its efficiency may be gauged by the fact that the temperature in the space behind the tubes is very moderate. The tubes are pitched so that radiation through the bank on to the casing is not possible.

The element before the superheater has five rows of tubes, which is enough to reduce the gases to a temperature sufficient to give the required superheat without an excessive size of superheater. The superheater is of the Yarrow type with U-tubes expanded into a drum. The tubes are nearly vertical, and, therefore, easily supported, and they are self-draining. A baffle, between the steam drum and the superheater loops, rests upon the outer tubes of the five-row element, and this has a channel fixed to its bottom edge to support the superheater tubes.

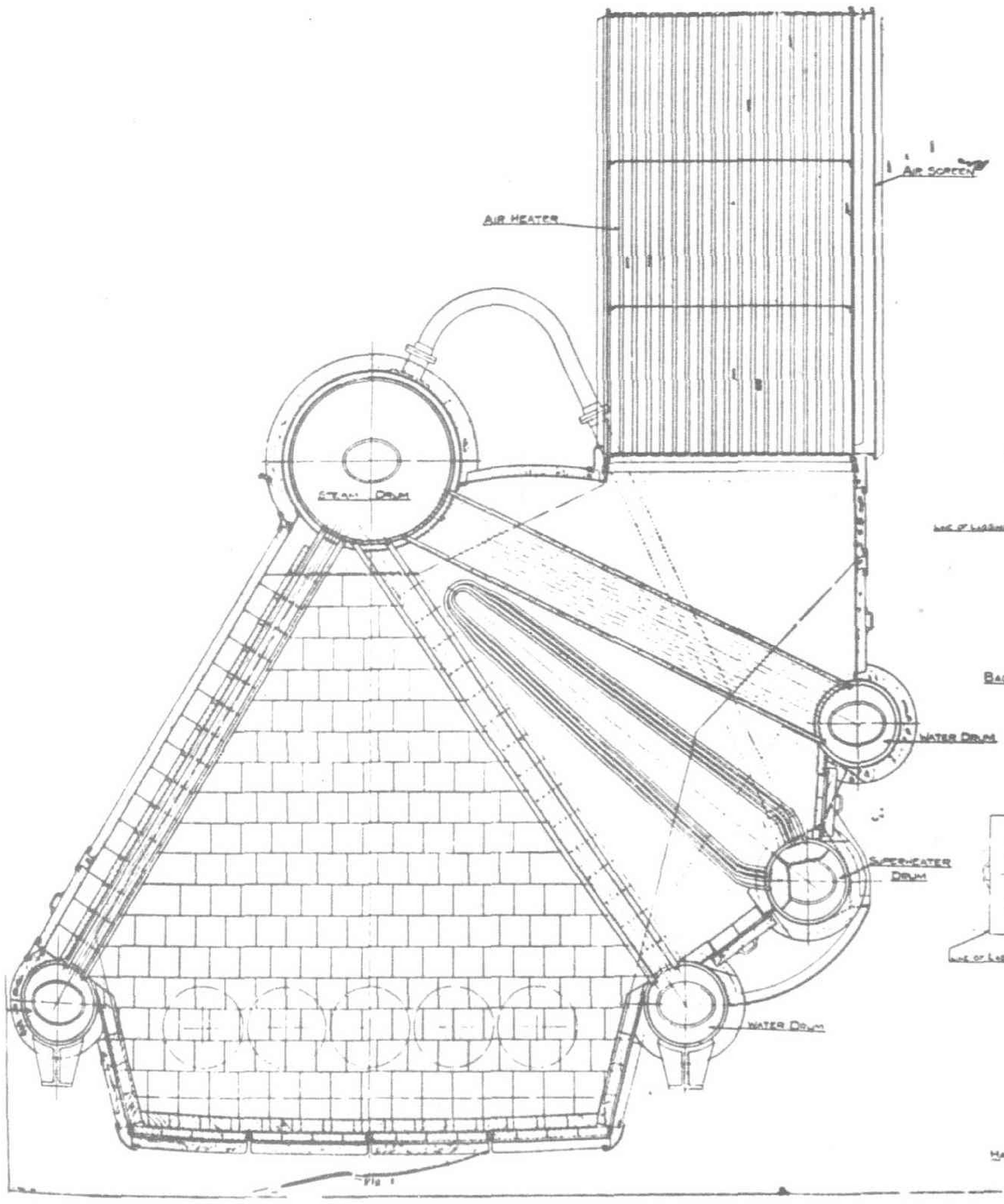


Fig. 1

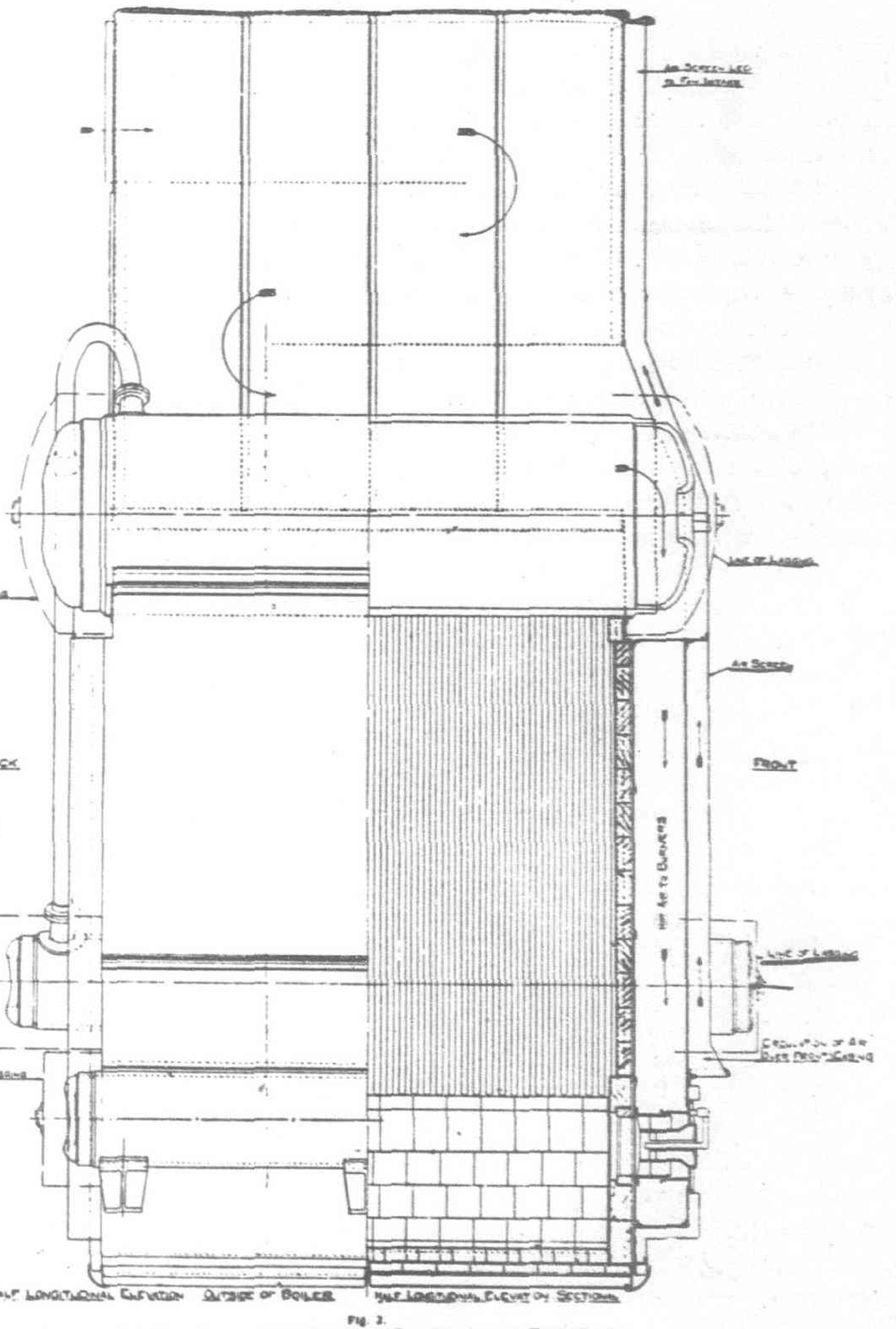

Air Screen Led to Fan Intake
Line of Lagging
Back
Front
Air Screen
Air to Burners
Line of Lagging
Circulation of Air over Front Casing
Half Longitudinal Elevation Outside of Boiler
Half Longitudinal Elevation Sectional
Fig. 2.

Fig. 2

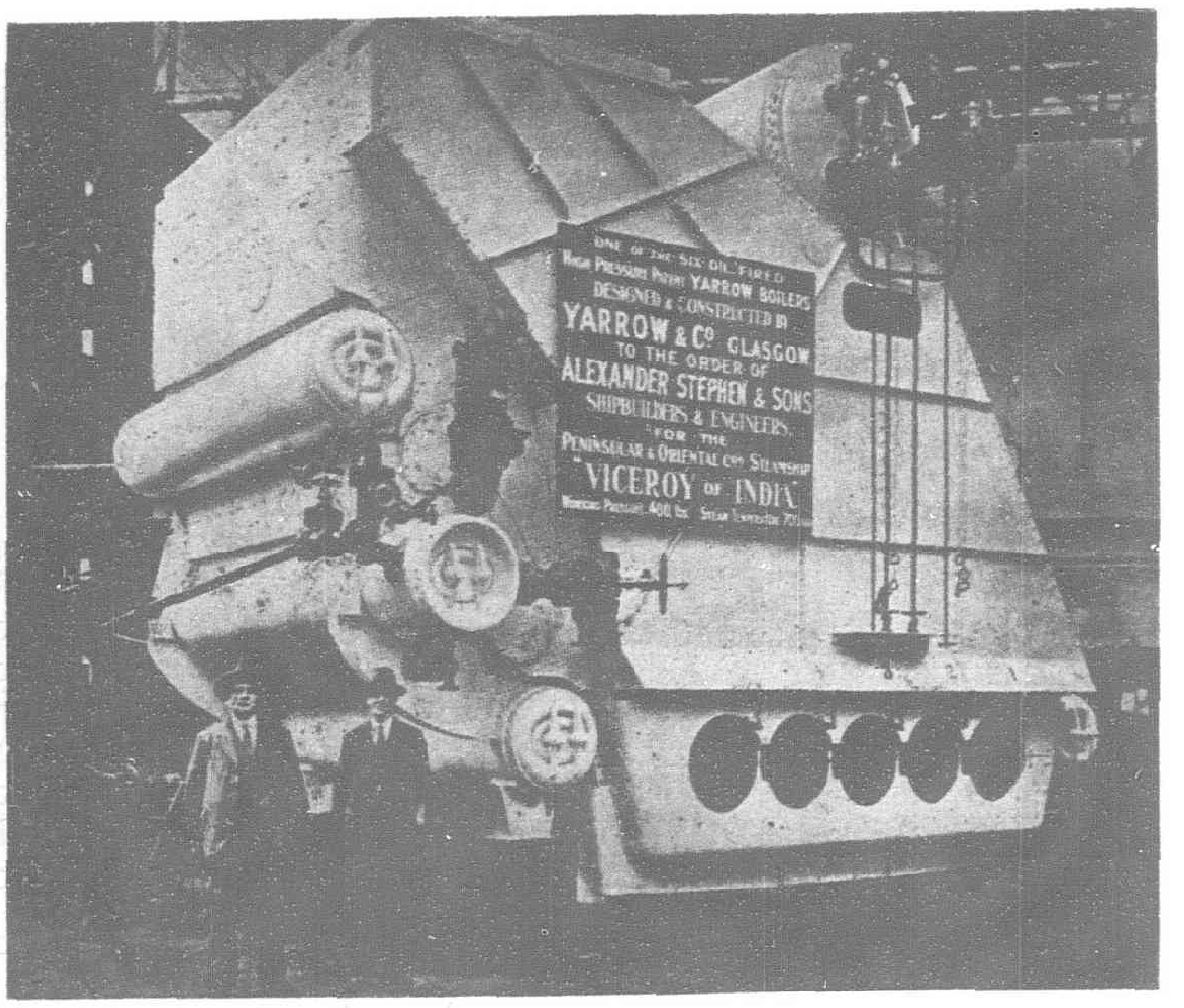


Fig. 3

The tubes are in four groups. The steam enters at one end, flows in series through them, being directed by the troughs fitted in the drum, and leaves at the other end of the drum where the main and auxiliary boiler stop-valves are fitted. The superheater drum is connected to the saturated steam drum by a pipe without any shut-off valve. Each and every tube in the superheater can be removed and replaced without disturbing the superheater drum.

After passing through the superheater, the gases flow through the upper generating element and then enter the airheater, which is of the Yarrow tubular type. The air makes three passes through the heater, and is then led over the boiler casing down to the oil burners. Retarders are fitted in the tubes.

The boiler casings are arranged in panels to allow easy access to all parts. They are of steel plates, with three inches of lagging covered with $\frac{1}{16}$ inch sheet steel. Great care was taken to cover all bars and other projections, and in consequence, the boiler-room temperature at the floor plate level is not much above that of the outside air. There is an air screen over the front boiler casing, and the outlet is led to the eye of the forced-draught fan, which ensures a current of cool air in the vicinity of the men attending the oil burners and a cool boiler front.

The importance of reducing riveted and bolted joints to a minimum, especially with high pressures, received careful consideration in working out the design, and attention is drawn to the fact that all the drums are solid forged with pressed-steel ends riveted in. There are, therefore, no longitudinal riveted joints, and in this type of boiler there are practically no bolted joints. It will also be noted that all the drums or headers are of a circular action, especially desirable with high steam pressures. The steel of the drums has an ultimate tensile strength of from 28 to 32 tons per square inch.

The tubes throughout are of solid cold-drawn steel. Although cold-drawn tubes are more expensive than hot-drawn tubes, it is important to obtain a good smooth surface, thereby reducing the risk of corrosion and, consequently, repairs, and, in my opinion, it is money well spent in obtaining the highest class of outfit.

The oil-burning installation was supplied by the Clyde Oil Fuel System Co., and as indicated on the drawing, Fig. 1, there are five burners on each boiler. The automatic feed regulator is of the latest Mumford pattern. The safety valve is of the Cockburn-MacNicoll high-lift type, and is fitted at the outlet end of the superheater. This also ensures that any steam taken from the boiler must pass through the superheater. All the other mountings, such as water-gauge fittings, auxiliary steam stop-valve, auxiliary feed check-valve, air valve, superheater drain-valve, were supplied by Messrs. Yarrow & Co., but the plate glass water-level indicator for the water-gauge fittings is of the Dewrance & Wall extra heavy pattern. Each boiler is also fitted with the Kelvin, Bottomley & Baird pneumercator gauge, this being fixed at a convenient height above the firing floor.

Two of the boilers have a saturated auxiliary steam connection, but this steam is also taken from the outlet end of the superheater, and passes through a de-superheater which is arranged in the steam drum, and thence to the stop valve on this drum.

The weight of each large boiler, complete with mountings, superheater, and airheater, is 86 tons. This includes seven tons of hot water. The corresponding figures for the smaller boilers are 80.75 tons and 6.5 tons.

PERFORMANCE

The specified boiler efficiency was 84 per cent. when producing the guaranteed amount of steam. Two consumption trials were run—one with four larger boilers in use, and the other with all six boilers under steam. Readings were taken at frequent intervals, and the following are the mean figures :—

1st Consumption Trial

Boiler pressure, lbs. per square inch	373 lbs.
Final temperature of steam, degrees F.	690
Nett feed-water per hour, lbs.	105,560
Feed temperature, degrees F.	279
Oil-fuel pressure, lbs. per square inch	80 lbs.
Temperature of oil at the burners, degrees F.	133
Air pressure at fans, inches	2.2
Air pressure at the furnaces, inches	.3
Temperature of air at fan inlet, degrees F.	50
Temperature of air entering airheater, degrees F.	54
Temperature of air leaving airheater, degrees F.	276
Temperature of air at air distributors, degrees F.	316
Temperature of gases entering airheater, degrees F.	530
Temperature of gases leaving airheater, degrees F.	322
CO^2, per cent.	14.5
Oil fuel per hour, lbs.	7,200
Calorific value of oil fuel, B.Th.U's. per lb.	18,700
Boiler efficiency, per cent.	86

2nd Consumption Trial

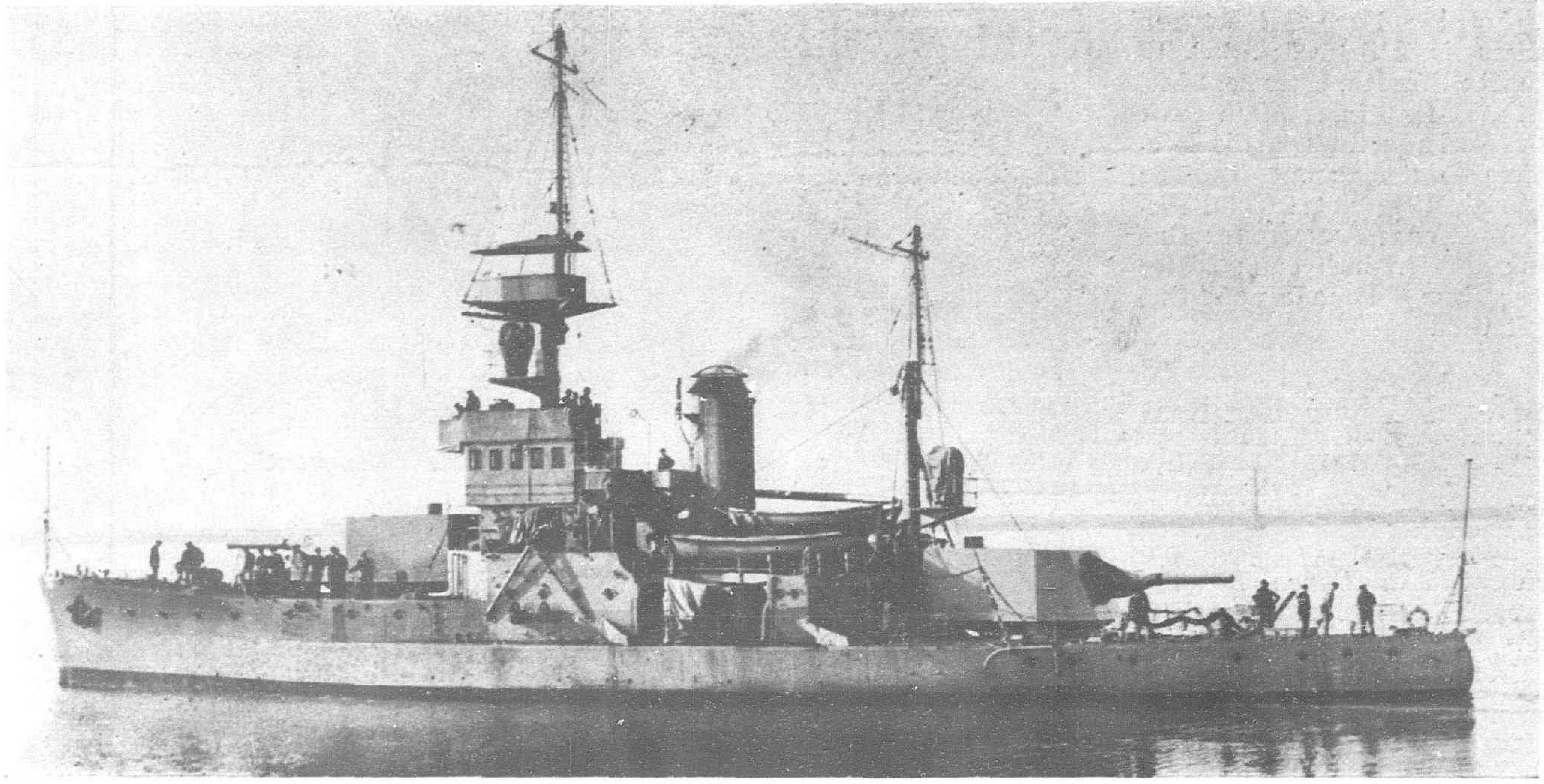
Boiler pressure, lbs. per square inch	378
Final temperature of steam, degrees F.	693
Nett feed-water per-hour, lbs.	148,420
Feed temperature, degrees F.	278
Oil-fuel pressure, lbs. per square inch	77
Temperature of oil at the burners, degrees F.	143
Air pressure at fans, inches	2.05
Air pressure at the furnaces, inches	.15
Temperature of air at fan inlet, degrees F.	66
Temperature of air entering airheater, degrees F.	72
Temperature of air leaving airheater, degrees F.	279
Temperature of air at air distributors, degrees F.	322
Temperature of gases entering airheater, degrees F.	527
Temperature of gases leaving airheater, degrees F.	332
CO^2, per cent.	14.7
Oil fuel per hour, lbs.	10,200
Calorific value of oil fuel, B.Th.U's. per lb.	18,700
Boiler efficiency, per cent.	87

On this trial the whole six boilers were in use for two-thirds of the time, after which one of the small boilers was shut down.

Up to the end of October the boilers had steamed over 3,000 hours, and Mr. Clarke states that the boiler efficiency in service averages 85 per cent.

The question of the durability of the furnace refractories is mentioned earlier in the paper, and on this point I have been informed by the Peninsular and Oriental Co. that about 300 bricks have been renewed. These cost about eightpence each, so that the price of brickwork for approximately 3,100 hours' steaming is only about £10. The cost of other repairs to the boilers is understood to be very low indeed.

High steam pressures and temperatures were used in marine engineering many years ago, but with indifferent success, and practically no attempt was made to continue the practice until two or three years ago. Since then great progress has been made, and several vessels with boilers such as are described in this paper have been put into service, and are giving entire satisfaction. The experience gained with these boilers, and the improvements in design thereby suggested, have enabled still higher efficiencies to be guaranteed for the boilers of installations of far greater power now building.



New Siamese Gunboat "Sukhodaya," Recently Completed by Vickers-Armstrongs, Ltd., Barrow-in-Furness

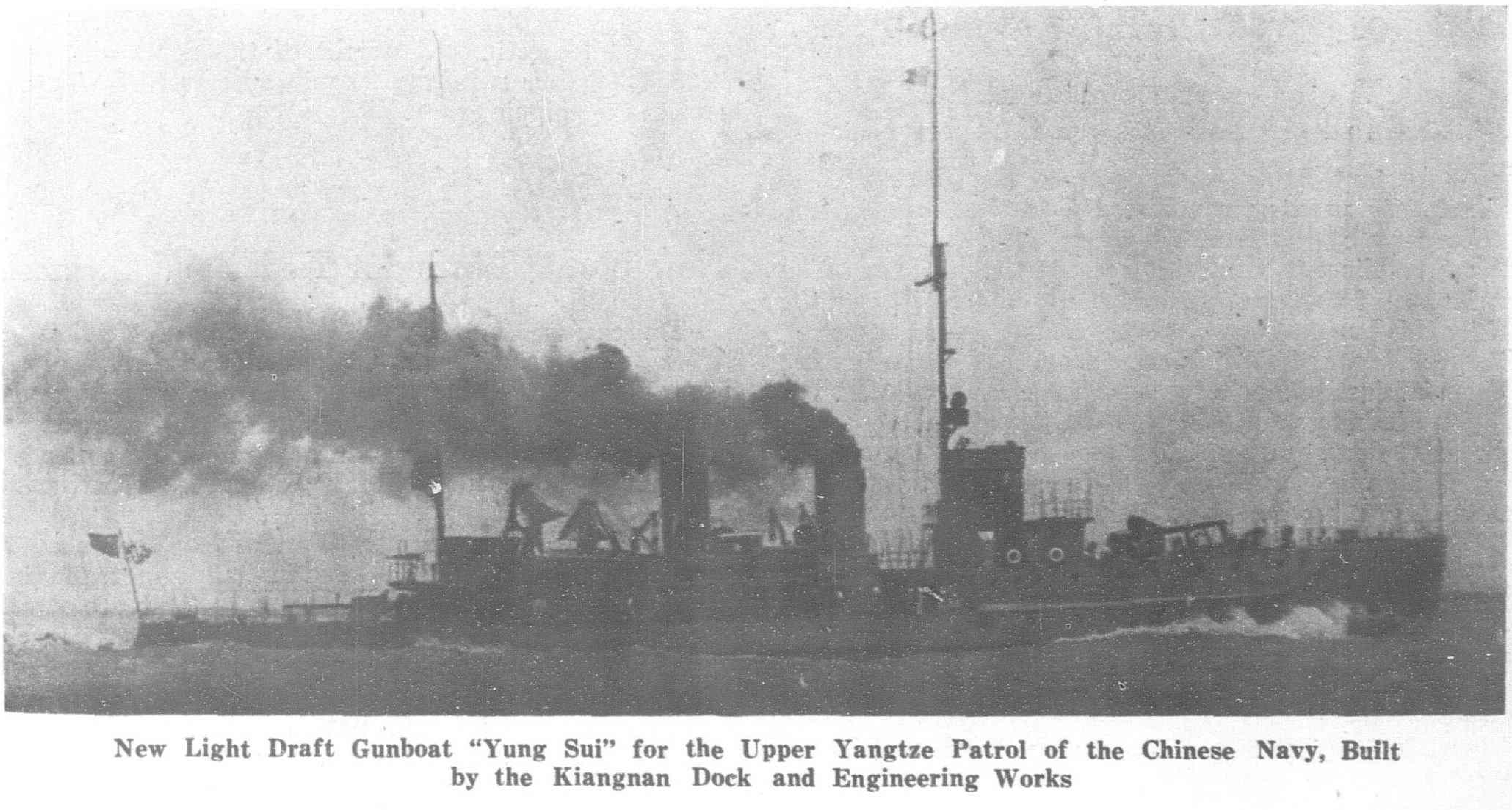
New Gunboats for the Siamese and Chinese Navies

The above photograph shows the new Siamese Gunboat *Sukhodaya* which was recently completed by Messrs. Vickers-Armstrongs, Ltd. at their Barrow-in-Furness Naval Construction Works. The gunboat has been specially designed for river, estuary, and coastline patrol service.

The *Sukhodaya* is a steel twin-screw ship with a length of 173 feet, and is similar to one built on the Tyne by Messrs. Armstrong Whitworth. She has armor belt of nickel steel fitted for her full length, with armor bulkheads and screens. The upper deck is plated with heavy steel to afford protection against aerial attack. She will carry two 6 inch guns and four 3 inch high angle guns with the latest system of fire control. Ammunition will be carried to the guns by electrical power. The main propelling machinery consists of two sorts of inverted triple-expansion engines capable of developing 850 horse-power, steam being supplied by two water tube boilers. Messrs. R. & W. Hawthorn Leslie, of Newcastle built the engines of the new gunboat.

Light Draft Gunboat "Yung Sui"

We are also permitted to present the photograph of another interesting light draft gunboat for the Upper Yangtze Fleet of the Chinese Navy. This vessel was completed last year by the Kiangnan Dock and Engineering Works and is now in active service.

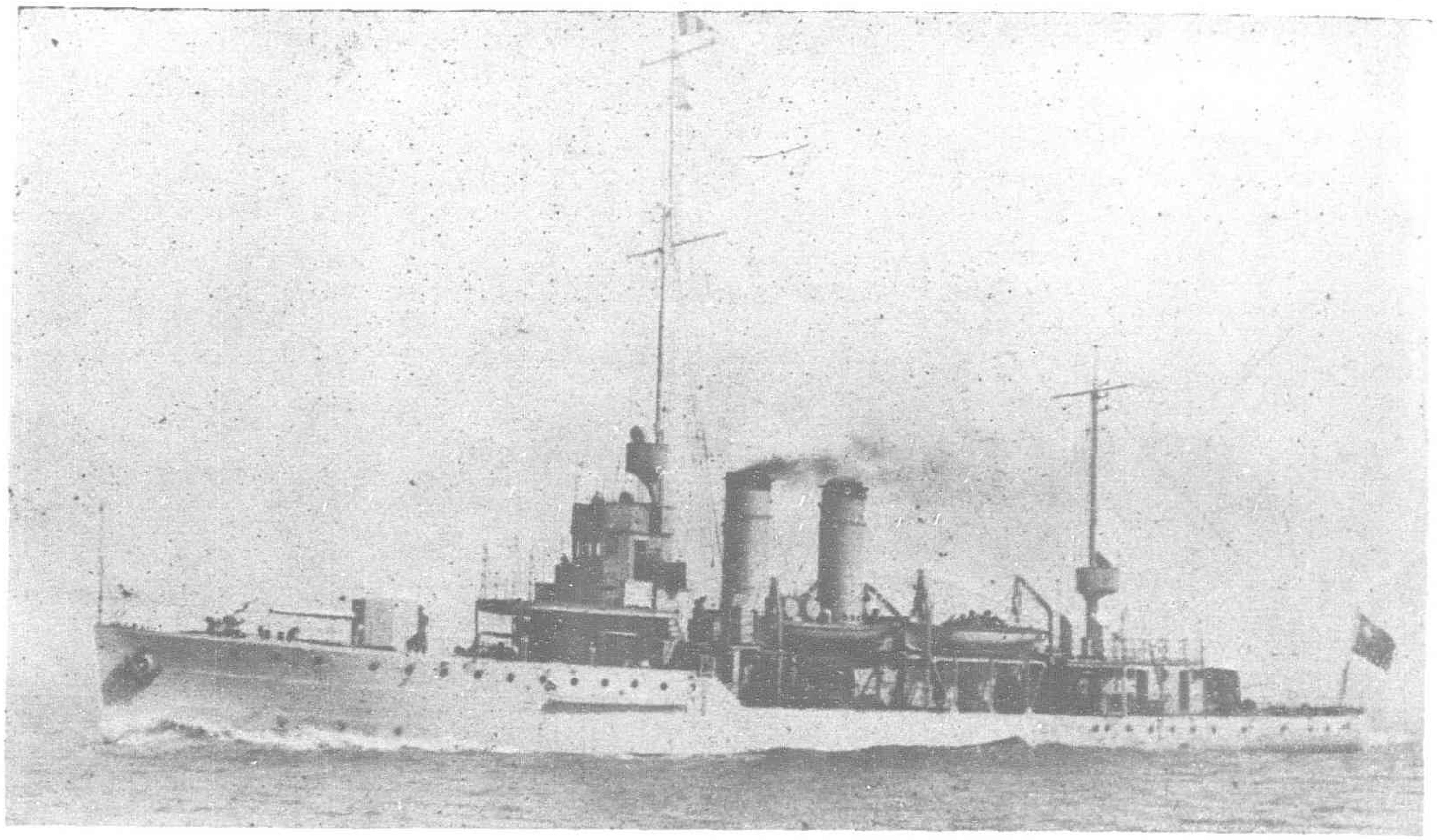


New Light Draft Gunboat "Yung Sui" for the Upper Yangtze Patrol of the Chinese Navy, Built by the Kiangnan Dock and Engineering Works

The length of the *Yung Sui* between perpendiculars is 210 feet; Breadth moulded, 30 ft; Breadth, extreme, 30 ft. 1 in.; Depth, 11 ft. 6 in.: Mean draft to bottom of keel at mean trial displacement in fresh water, about 6 feet.; Speed on Trial, 18½ knots; Total Displacement, 600 Tons; **Armament**: One 6 inch gun; One 4.7-inch gun; Three 3 inch guns; Four 6 Pounders and One Anti-aircraft Gun.

Chinese Naval River Gunboat "Min Chuan"

The Kiangnan Dock and Engineering Works has also just completed the River Gunboat *Min Chuan* for the Chinese Navy. The principal dimensions of this new addition to the Chinese Yangtze patrol, are as follows :—



Chinese Naval River Gunboat "Min Chuan," Built by the Kiangnan Dock & Engineering Works

Length overall, 196 ft. 8¾ in.: Length between perpendiculars, 183-ft. 4½ in.

Breadth, moulded, 26 ft. 0 in.: Depth moulded, 11ft. ¾ in.
Draft (normal) 6-ft.: Displacement 460 tons; I.H.P. 2,600; Speed 18 knots.

Armament: One 4.7-in. Q.F. gun on bow;
One 4-in. Q. F. gun on stern;
Three 6 pounders on bridge and forecastle;
Six machine guns on bullet proof shield mountings.

Machinery: The propelling machinery consists of two sets of high speed inverted direct acting surface condensing triple expanison engines. Steam is supplied by two Thornycroft water tube boilers at a working pressure of 250 lbs per square inch.

Accommodation: Appropriate accommodation is provided for a total complement of 100 men.

The Modern Bank Vault

(Continued from page 250).

the past. Vaults that will give protection from any source of attack is the heart of a bank and any banker who overlooks the above facts will later find himself on the tail end of the procession.

In observing the prominent display advertising that is being done by the banks in America to-day, we are convinced that bankers like merchants must have convincing sales talks to sell their service to the public.

Bank of Japan's New Vaults

Largest Bank Vault Contract outside of New York Awarded to York Safe & Lock Company

The most important bank vault contract placed outside of New York city was recently awarded to the York Safe & Lock Company by the Bank of Japan. The erection of the many new bank buildings in Tokyo after the earthquake, has called for the installation of the most modern vault equipment, and the competition for this business has been very keen.

The Bank of Japan, following the example of the other big Japanese financial institutions of the capital, invited plans for the construction of a new vault 180 × 80-ft. two stories high with four vaults on each floor, and total floor area of 28,800 square feet. The contract, finally placed with the York Safe & Lock Co., through their agents in Japan, the American Trading Company, at a cost of nearly $500,000 gold, provides for vault walls 30 inches thick, with three layers of ½-in. open heath steel lining, of a total weight of nearly 2,400 tons. There will be seven main entrance doors, of which six are 36 inches thick and one of 24 inches; nine emergency entrance doors 36 inches thick and one 24 inches. These doors are not the York standard type, but are to be constructed according to plans drawn by Mr. Homes, the Bank's consulting engineer in New York. The doors will be equipped with the following specialties :—

Double perescopic combination locks.
96 hour 4 movement Yale time locks
18 locking bolts 5-in. in diameter.
Door castings 2½-in. thick.
Clear door opening 48 × 80-in.
Outside bolt frames 5 × 7½-in.
Crane hinges, 6-in. thick 22-in. wide, tensil strength 60,000 pounds per square inch.
Pressure bars 3-in. diameter.
Pressure wheel 26-in. diameter.
Main hinge pins 7-in. diameter.
Steel balls in foot hinge 1½-in. diameter.
Raceway washers 1¾-in. thick
Friction pins in main hinge bearings 1-in. diameter.

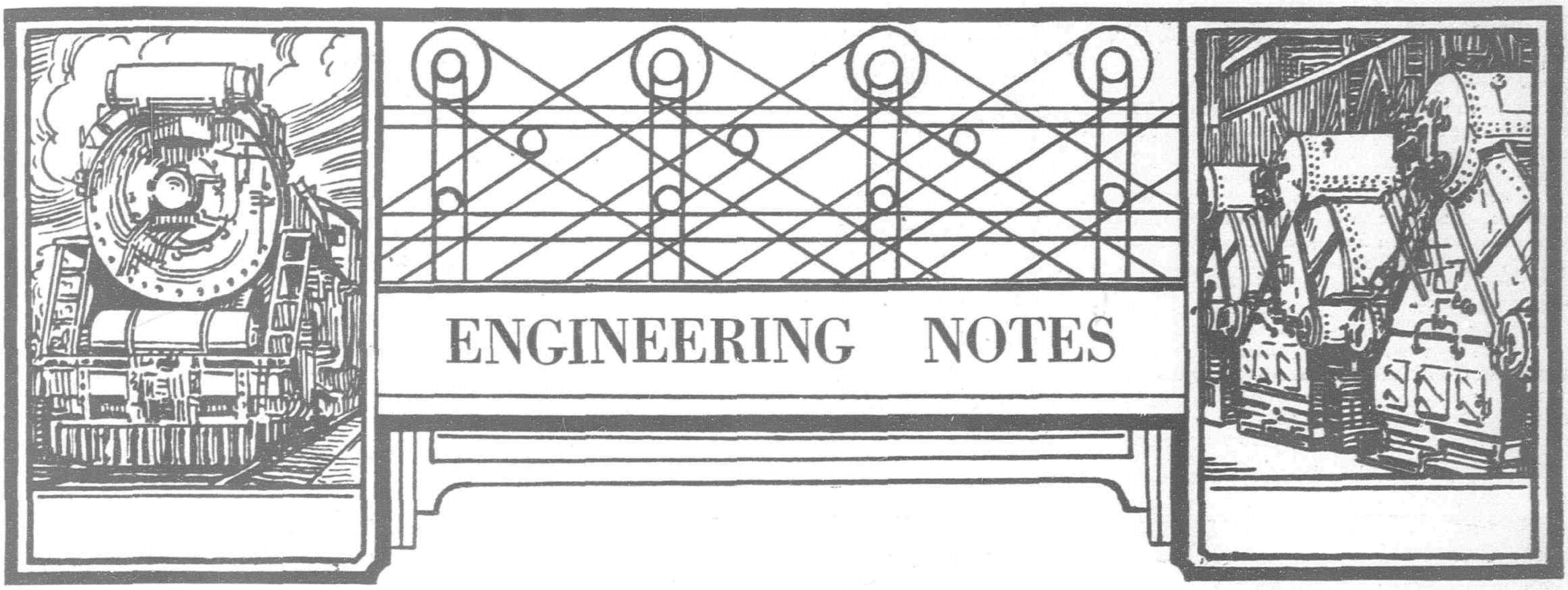
The total estimated weight of the doors and equipment is about 3,000 tons requiring 60 railway cars to transport the shipment to the shipping port.

New Motor Liner for Nederland Steamship Co.

The end of March saw the launching of the first of the new "T" class motor cargo liners for the Nederland Steamship Company's cargo service to the East Indies, which was in every way successful.

The vessels of this class are of the full scantling type with forecastle, bridge, and poop, and are of 465 feet length, 62 feet breadth, and 36 feet 3 inches depth, and are constructed to carry about 10,000 tons.

Cargo is carried in five holds and a deep tank abaft the engine room. Two lower holds have been specially adapted for the carriage of palm oil in bulk. For handling cargo there are eleven derricks for lifts of three to six tons each, with three heavy derricks for lifts of 15, 20, and 40 tons respectively, and a requisite number of electric winches together with six electric dock cranes. Provision has been made for the carriage of native pilgrims. A Sulzer diesel engine of 7,000 b.h.p., constructed by Messrs Sulzer Brothers, will give a mean speed of 15 knots.



ENGINEERING NOTES

ELECTRIC LIGHT, POWER AND TRACTION

HYDRO-ELECTRIC SCHEME IN CEYLON.—The "Ceylon Daily News" states that the continental firm of "Siemens—Bau-Union" has made a proposal to Government regarding the construction of the Hydro-Electric Scheme, and that it will come up for consideration before the Legislative Council in connection with the Government's Bill on the Scheme.

NEW ELECTRIC LIGHT FRANCHISES, PHILIPPINE ISLANDS.—The Philippine Assembly at its last session passed bills granting franchises for the installation, operation and maintenance of twenty-two municipal electric light and power plants, as follows :—

1. All Municipalities of the Island of Camiguin, Province of Misamis, to Leon Borromeo.
2. Municipality of Passi, Province of Iloilo, to Moises Iturralde.
3. Municipality of Romblon, Province of Romblon, to the "Red Rovers Society."
4. Municipality of Tayabas, Province of Tayabas to the Tayabas Light and Power Company.
5. Municipality of Orani, Province of Bataan, to Pablo Salaveria.
6. Municipality of Valencia, Province of Bohol, to Rufino Ramirez.
7. Municipality of San Carlos, Province of Occidental Negros, to the "San Carlos Electric Light Company."
8. Municipality of Toledo, Province of Cebu, to Ignacio Rafols.
9. Municipality of Ronda, Province of Cebu, to Aquilino Lucero.
10. Municipality of La Castellana, Province of Occidental Negros, to Ramon Del Castillo.
11. Municipality of Camalig, Province of Albay, to Jose S. Valenciano.
12. Municipalities of Iloilo, La Paz, Jaro, Arevalo, Santa Barbara and Pavia, Province of Iloilo, to Esteban de la Rama.
13. Municipality of Guiwan, Province of Samar, to the "Guiwan Electric Plant Co., Inc."
14. Municipality of Baclayon, Province of Bohol, to Jose G. Zarraga.
15. Municipality of Laoang, Province of Samar, to the "Laoang Electric Company."
16. Municipality of Oton, Province of Iloilo, to Ricardo Carreon.
17. Municipality of San Antonio, Province of Nueva Ecija, to Mariano R. Lamson.
18. Municipality of Jimalalud, Province of Oriental Negros, to Antonio V. Garces.
19. Municipality of Tuburan, Province of Cebu, to Jose A. Veloso.
20. Municipalities of Balamban and Asturias, Province of Cebu, to Jose Alonso.
21. Municipality of Loboc, Province of Bohol, to Pedro Changco.
22. Municipalities of San Pablo and Alaminos, Province of Laguna, and Municipalities of Dolores and Tiaong, Province of Tayabas, to the Escudero Electric Service Company.

INDUSTRIAL

JAPANESE PAINT AND VARNISH INDUSTRY.—A note in the "Journal of the Society of Chemical Industry of Japan" gives the number of large and medium size concerns engaged in the pigment, paint and varnish industries as 99, with a total capital of 17 million yen. There are also 21 small plants. The biggest producers are the Nippon Paint Company and the Nippon Chemical Company, each with a capital of 5 million yen. Production in 1928 of varnishes, oils and water colours, was worth 25 million yen, and of pigments, 18 million yen. The principal pigments manufactured are zinc white and red lead, but there are also made considerable amounts of litharge, barium sulphate, lithopone, white lead, iron oxide, chrome yellow, ultramarine, Berlin blue, etc. Home output fully meets the needs of the markets in the cheaper oil colors and varnishes, in which there are practically no imports, whilst an appreciable export trade is done with China and the East Indies. The principal imports are the more expensive oil varnishes, cellulose lacquers, and anti-fouling paint for ships. In regard to the first mentioned products, imports in 1928 were about 600 tons, in the second group 277 tons, and in the third group 284 tons.

RAILWAYS

DIESEL-ELECTRIC LOCOS FOR INDIA.—The General Electric Co., Ltd., has recently completed the electrical equipment for two Diesel-electric locomotives for the North Western Railway, India. These locomotives are to the order of the High Commissioner, and the Consulting Engineers for the work are Messrs. Rendel, Palmer & Tritton.

The locomotives each weigh approximately 50 tons in working order, and are of the double bogie type. They are each equipped with a 350 B.H.P. Beardmore high-speed Diesel engine, direct-coupled to a single bearing generator with overhung exciter. The generator supplies current to four traction motors mounted upon the bogie axles, control being effected by master controllers located in the driver's cabs at either end of the locomotive. The locomotives are designed to haul loads up to 100 tons at a maximum speed on the level of approximately 47 m.p.h. and at correspondingly less speeds on gradients up to 1 in 50.

The locomotives are designed for the Indian track gauge of 5-ft. 6-in., but the bogies of one locomotive are being modified to the standard British gauge of 4-ft. 8½-in. to enable a number of tests to be conducted on the locomotive before shipment.

NOTE.

The article, "The Japanese Empire as a Mineral Producer" by J. Norman Wynne, F.G.S., M.Inst.M.M. Late General Superintend of the Toi Gold Mining Co., Ltd., Japan, which appeared in our June, 1929 issue originally appeared in the *Mining Magazine*.

TELEPHONE, TELEGRAPH AND RADIO

FUSHUN TELEPHONE SERVICE.—Since January 26, The Fushun Colliery town. Yungantai has been connected with the Collieries. The Fushun telephones will have 1,639 subscribers consisting of 976 for the Collieries Management, and the remaining 664 for the public. Outside the Leased Territory. Fushun will rank only second to the Railway. Town of Mukden. For effecting the much-desired connection, the Collieries Management have had to lay out Y.130,000, whilst it has cost the Post Office Y.20,000.

A program providing for repairs and improvements to all Government telegraph lines throughout the country has been formulated by the Telegraph Administration Department of the Ministry of Communications. It is estimated that a period of six years will be required for the completion of the entire program which will entail an expenditure of approximately $3,700,000.

During the first year a total of 4,773 miles (14,320 li) of the telegraph lines will be renovated, including the Nanking-Hankow, Peiping-Tientsin, Hangchow-Foochow, Foochow-Amoy, Swatow-Canton, Peiping-Hankow, Kiukiang-Canton, Hsuchow-Chengchow Main Telegraph Lines and various other branch lines attached thereto.

During the second year, 3,398 miles (10,195 li) of lines will be repaired, including the Hankow-Canton, Hsuchow-Tsingkiangpu, Hankow-Chungking and Kalgan-Lanchow Lines.

In the third year, 2,984 miles (8,953 li) of other lines will be repaired, including the Chengchow-Sian, Sian-Lanchow, Tsingtao-Tsinan, Tsingtao-Tsingkiang, Hsuchow-Haichow, Taiyuan-Shihkiachwang, Anking-Wusuch and Wuchang-Kweilin Lines.

The next three years will be devoted to the replacement of old apparatus and other improvements for the various main and branch lines.—*Kuo Min.*

RADIO STATIONS PLANNED.—With a view to increasing interest in radio throughout the country the Japan Broadcasting Association had filed application with the Communications Department for permission to establish five minor radio broadcasting stations during this fiscal year at Nagano, Kyoto, Shizuoka, Okayama, and Fukuoka.

The five stations are to be equipped with apparatus of 500 watt capacity and all stations, except Nagano, are to be relayed by remote control, Nagano being served by direct wireless.

The Kanazawa Broadcasting Station (J.O.J.K. Wave length 423 meters) is near completion and is expected to be opened shortly.

ROADS

HIGHWAYS IN BARGA.—There are a number of highways in Barga, or Hulunpuer, the steppe territory lying between the Hingan mountains in Heilungkiang province and Mongolia. The most significant road is that between Hailar and Halhin-gol, which is only part of the long highway between Hailar and Dolonor. Dolonor is a Mongolian word, *Dolon* meaning seven and *nor* lakes, because the city is situated near the seven lakes in south Mongolia of the territory of Chahari, 1,100 kilometers from Hailar. This highway has been in existence for several centuries, running along the left bank of the Imien-gol river, intersecting the Huhai-gol river at the bridge bearing the same name, then passing through the territory of Golhuhu and Hoshu-suma into the old Zhanzhun-suma (suma is a Mongolian word for temple), where the highway splits into two roads. One of the branch roads cuts into the rich valley of Doloti river and the other turns westward, the two meeting each other again in the territory of Halha, proceeding thence to the territories of Siling-gol, Judan-siems Chahari, ultimately reaching Dolonor, whence the highway proceeds further to Kalgan and Tientsin.

The portion of the highway between Hailar and Dolonor extends 300 miles into the Barga territory touching Ganjour-suma in western Barga. Before the construction of the Chinese Eastern Railway this highway had great economic importance, throughout the year caravans of camels and trains of carts carrying home manufactured goods from Dolonor to Barga, and pelts, wool and hides from the interior of Barga to Dolonor.

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